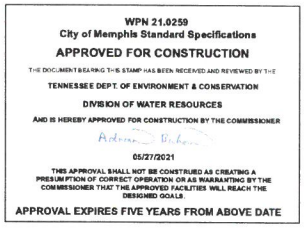
CITY OF MEMPHIS

STANDARD CONSTRUCTION SPECIFICATIONS FOR SANITARY SEWERS AND APPURTENANCES

Issued for State approval

Prepared by: City of Memphis
Division of Engineering
Sewer Design Department



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CITY OF MEMPHIS – STANDARD CONSTRUCTION SPECIFICATIONS
SECTION 02530 SEWER PIPE INSTALLATION

PART 1 - SCOPE

1.01 This Work will consist of the construction of sanitary sewers, siphons, and service connections of the kinds and dimensions shown on the Plans, stipulated in the Contract Documents, or as directed by the Engineer. The construction will be accomplished by these Specifications and in conformity with the lines, grades, and details shown on the Plans or established by the Engineer. The Contractor will perform all work necessary to complete the Contract with the best modern practice. Without specifications that state the quality of any work, the Contractor is required to perform such items using first-quality construction. Unless otherwise provided, the Contractor will furnish all material, equipment, tools, labor and incidentals necessary to complete the Work.

1.02 The Engineer may change the Plans, Specifications, character of work or quantity of work, provided the cost of the changes does not exceed 10% of the contract price.

PART 2 – MATERIALS AND EQUIPMENT

2.01 MATERIAL

A. Construction Material

1. All material furnished by the Contractor will be new, high quality and free from defects. Previously used material in acceptable condition may be used for bracing, forms, false work, and similar uses. Material not conforming to the requirements of the Specifications will be considered defective and will be removed immediately from the site.

B. Higher Strength Pipe

1. The Contractor may substitute a higher strength pipe of the same type as that specified subject to the approval of the Engineer.

C. Qualifications of Manufacturers

1. Pipe for sanitary sewers will be the standard product of an established, reputable manufacturer made in a permanent plant. Suppliers for each material to be used by the Contractor will be subject to approval by the Engineer. No material will be delivered until the manufacturer and product have been approved by the Engineer. For any construction project, pipe and appurtenances for each pipe material shall be the product of a single manufacturer having a minimum of 10 years domestic experience producing the type of pipe supplied.

D. Material Inspection and Testing

1. Representative samples of material intended for incorporation in the work will be submitted for examination when so specified or requested. All material to be used in the work will be sampled, inspected, and tested by current ASTM specifications, or other standard specifications. The Contractor will furnish the Engineer with three copies of certified reports from an accredited testing laboratory showing the results of the tests carried out on representative samples of material to be used on the Project. Each length of pipe delivered to the project will show the laboratory's stamp. The performance or cost of all testing is the responsibility of the Contractor.

2. The Contractor will notify the Engineer before any deliveries of material and will make whatever provisions are necessary to aid the Engineer in the inspection and culling of the material before installation.

E. Storage

1. The Contractor will provide and maintain storage facilities and exercise such measures to maintain the specified quality and fitness of material to be incorporated in the work. The interior and sealing surfaces of the pipe, fittings and adapters will be kept free from dirt and foreign matter. PVC pipe, fittings, and adapters stored outside and exposed to sunlight will be covered with an opaque material with proper ventilation.

F. Prestressed Concrete Cylinder Pipe

1. All prestressed concrete cylinder pipe shall conform to the requirements of AWWA C 301 and C 304 and will be designed for a variable depth of cover as shown on the profile; the maximum trench loading that can occur on an empty pipe after backfill is in place; and a live load equal to the AASHTO HS20 loading or the minimum live load as specified in AWWA C 301, whichever is greater. The interior surface of the pipe will be a smooth, cylindrical surface. Cement will meet all the requirements ASTM C 150, Type II. Steel cylinder shall be made of steel sheets not lighter than No. 16 gauge with a minimum yield strength of 33,000 psi, and conforming to the requirements of "Standard Specification for Hot-Rolled Carbon Steel Sheets and Strip Structural Quality", Grade 33, ASTM designation A 1011. Steel used for the bell rings for pipe and fittings shall have a minimum yield strength of 30,000 psi and conform to the requirements of ASTM A 1011. Steel plate and special shapes for spigot joint rings shall conform to the requirements of ASTM A 36 or the other ASTM specifications listed in AWWA C 301. High tensile prestressing wire shall be a minimum of No. 6 gauge and maximum class shall be Class III. The wire shall conform to the requirements of "Standard Specification for Steel Wire, Hard-Drawn for Prestressing Concrete Pipe", ASTM A 648. No lifting holes will be allowed. The pipe will be furnished complete with gaskets, grout bands and lubricant as required for proper installation.

2. The interior of all 36 inch and larger diameter pipe will be fully lined with a PVC liner as specified in Section 02530 Paragraph 2.01.DD. The liner will be installed by the pipe manufacturer prior to pipe delivery.

3. The liner will be welded at each joint after installation and testing of the pipe. Exceptions to the welding requirement may be granted at the direction of the Engineer.

4. Fittings shall be composed of cut and welded steel plate with all welds inspected, and the completed cylinder shall be tested for tightness by the dye penetrant method. Fittings shall have wire reinforcement applied to the interior and exterior surfaces. Concrete and mortar linings shall be at least 3/8 inch thick and exterior mortar coating shall be 1 inch thick unless otherwise indicated. All materials and workmanship shall be as specified in AWWA C 301.

a. Curves of long radius may be formed by the use of pipe on which the spigot joint rings are placed on a bevel or by the use of bevel adapters. Special pipes shall be designed to provide the same strength as the adjacent pipe. Branch connection or openings, such as manholes and bypass pumping connections, shall be incorporated in straight pipe and shall be suitably reinforced. Special pipes shall be provided with joint rings corresponding to those on adjoining straight pipes. Special ends shall be provided on concrete pipe, where required to connect to pipe of other manufacturers and special structures.

G. Reinforced Concrete Pipe

1. All reinforced concrete pipe for gravity sewer applications will conform to the requirements of ASTM C 76 for circular pipe, Wall B for the specified diameter and strength class. If no class is specified, Class III pipe will be used. The interior surface of the pipe will be a smooth, cylindrical surface. Cement will meet all the requirements ASTM C 150, Type I. No lifting holes will be allowed. The pipe will be furnished complete with gaskets, grout bands and lubricant as required

for proper installation. Pipe will be designed for a 0.01 inch crack D-Load. The ultimate D-Load will be at least 1.5 times the 0.01 inch D-Load.

2. The interior of all 36 inch and larger diameter pipe will be fully lined with a PVC liner as specified in Section 02530 Paragraph 2.01.DD. The liner will be installed by the pipe manufacturer prior to pipe delivery.

3. The liner will be welded at each joint after installation and testing of the pipe. Exceptions to the welding requirement may be granted at the direction of the Engineer.

4. Joints in reinforced concrete pipe less than 30 inches in diameter will have compression gaskets or trapped O-ring gaskets. Pipes 30 inches in diameter or greater will have trapped O-ring gaskets meeting the requirements of ASTM C 443. When required, concrete pipe ends will be manufactured with steel bell and spigot end rings with a groove on the spigot for an O-ring rubber gasket. This joint will meet the joint requirements of ASTM C 443 and ASTM C 361. The shape, dimensions, and tolerances of the bell and spigot or tongue and groove ends of the pipe will meet the requirements of ASTM C 443. The ends of the rubber gasketed pipe will be accurately manufactured so that, when adjacent pipe sections are drawn together, the rubber gasket will be uniformly compressed around the periphery of the pipe to provide a watertight seal.

H. Ductile Iron Pipe and Fittings

1. Ductile iron pipe for gravity sewer and service connections will conform to ASTM A 746. Ductile iron pipe for force main applications will conform to ANSI A 21.51. The pipe thickness design will conform to ANSI A 21.50. If no thickness class is specified on the Plans or Contract Documents, Class 50 or approved equivalent will be used. All ductile iron pipe will be lined with either Protecto 401 Ceramic Epoxy, SewPer Coat Cement Mortar Lining, or Polyethylene. Linings will be applied according to manufacturer's recommendations. Fittings will conform to the requirements of ANSI A 21.10. Unless otherwise specified, joints will be push-on gasket type conforming to the requirements of ANSI A 21.11. Mechanical joints will conform to the requirements of ANSI A 21.11. Flanged joints will conform to the requirements of ANSI A 21.15. Flexible joint ductile iron pipe for river crossing applications will conform to ASTM A 536 and will be Grade 70-50-05. Steel retainer rings will conform to ASTM A 148 for Grade 90-60.

I. Deleted.

J.

J.01 Polyvinyl Chloride (PVC) Gravity Pipe and Fittings (8-15 inch Diameter)

1. All PVC gravity pipe and fittings 8-15 inches in diameter shall be solid wall PVC; no profile wall PVC pipe is allowed for pipes 15 inches or less in diameter. PVC solid wall pipe and fittings for gravity sewer applications will conform to the requirements of ASTM D 3034. The standard dimension ratio (SDR) will be SDR 26 (Type PSM). PVC resin will conform to ASTM D 1784 cell class 12454C. A different cell class will be allowed only if the material meets the requirements of a superior cell class than 12454C. Fittings for PVC gravity sewer pipe will be fabricated from PVC meeting the respective ASTM PVC pipe standard for molded or extruded PVC. The wall thicknesses of the waterway and bell of fittings will be no less than the respective minimum thicknesses for the equivalent pipe. All fittings will be compatible with the pipe to which they are attached.

2. All PVC gravity pipe joints will be gasketed bell and spigot push-on type conforming to ASTM D 3212, unless directed otherwise in these Specifications. Gaskets will be part of a complete pipe section and purchased as such. Lubricant will be as recommended by the pipe manufacturer.

3. Solvent welded PVC saddle wye's may only be used on existing PVC and truss gravity sewer mains. Collar joints for fittings will be either Type SC (solvent cement) or Type OR (flexible gasketed compression joint) and will conform to the requirements of ASTM D 2680.

J.02 Polyvinyl Chloride (PVC) Gravity Pipe and Fittings (6 inch Diameter) Service Connection

6 Inches in diameter service connection may conform to either the SDR 26 Specification (ASTM D1784) or to ASTM D1785 and ASTM D 2665 (Schedule 40). All pipe and fittings to be produced by a single manufacturer and to be installed in accordance with manufacturer's recommendations and Shelby County, Tennessee code requirements. Solvent cements shall conform to ASTM D 2564. Primer shall conform to ASTM F 656.

K. Polyvinyl Chloride (PVC) Pipe and Fittings (18-36 inch Diameter)

1. All 18-36 inch diameter PVC gravity sewer pipe and fittings shall be designed and manufactured in accordance with ASTM F 679, F 794, F 949, or F 1803. All PVC sewer pipe and fittings shall be manufactured from PVC resin with a cell classification of either 12454C or 12364C as defined in specification ASTM D 1784. The pipe shall be furnished complete with gaskets, fittings, lubricant, etc. as required for proper installation and completion of the line. The minimum pipe stiffness at 5% deflection shall be 46 psi when tested in accordance with ASTM D 2412 and as specified in ASTM F 679, F 794, F 949, or F 1803, as applicable. Samples of the type of pipe to be used shall be tested in accordance with ASTM D 2412. Impact tests shall be conducted in accordance with ASTM D 2444 and shall comply with ASTM F 679, F 794, F 949, or F 1803. Tests may be conducted by the manufacturer in the presence of the Engineer. The City shall have the right to make unannounced visits to the pipe manufacturer's facility to inspect the manufacturing process.

2. All joints shall be the bell and spigot type and conform to ASTM D 3212. Gaskets shall meet ASTM F 477. All bells shall be formed integrally with the pipe and shall contain a factory installed elastomeric gasket which is positively retained. No solvent cement joints will be permitted in field construction.

3. The pipe manufacturer shall furnish to the Engineer a notarized certificate(s) of inspection stating that each piece of pipe used on this project was made and tested in accordance with these specifications.

4. All pipeline material shall be generically the same throughout the project with the permissible exception of utilizing different material for piping used for tie-ins of smaller lines, or as noted on the plans or as approved by the Engineer.

L. Glass Fiber Reinforced Polymer Mortar Pipe and Fittings up to 72 inch Diameter

1. Pipe shall meet the requirements of ASTM D 3262 - Standard Specification for Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe. The pipe shall be manufactured to form a dense, non-porous, corrosion-resistant, composite pipe that is resistant to corrosion from hydrogen sulfide and other corrosive materials normally found in sewerage systems, all without the use of special HDPE or PVC liners.

2. Minimum acceptable nominal length for joints of pipe shall be 20 feet except where field conditions require otherwise or approved by the Engineer.

3. Design: The design of the pipe shall comply with all requirements of the latest revision of ASTM D - 3262 for non-pressure (gravity) flow conditions. The pipe shall also be designed for a variable depth of cover as shown on the profile; the maximum trench loading that can occur on an empty pipe after backfill is in place; and a live load equal to the AASHTO HS20 loading or the minimum live load as specified in the latest revision of ASTM D - 3262, whichever gives the greater live load.

4. Resin Systems: These shall be only polyester resin systems with a proven history of satisfactory performance in sewage applications. Historical data shall have been acquired from a composite material of similar construction and composition.

5. Glass Reinforcements: Reinforcing glass fibers used in the manufacture of the pipe shall be of the highest quality commercial grade E-glass filaments with binder and sizing compatible with impregnating resins.

6. Interior Lining: All interior surfaces of the pipe shall be lined with a fiberglass reinforced polyester lining as a part of the manufacturing process.

7. Joints: The pipe shall be field connected with fiberglass sleeve couplings that utilize full face elastomeric sealing gaskets of EPDM rubber compound, providing a zero leakage joint. The coupling shall be factory assembled to one end of the pipe. Each joint shall be tested after installation in accordance with Specification Section 02530 4.02.

8. Tests and Examinations: Tests, in-process and final examinations shall be performed by the manufacturer, or an independent testing laboratory approved by the Engineer, in accordance with the latest revision of ASTM D 3262, in order to assure conformance. All instruments, gauges, and other testing and measuring equipment shall be of the proper range, type and accuracy to verify conformance and test equipment shall be checked at least annually against calibrated and certified test gauges and instruments. The Engineer shall have access to all records of tests and inspections related to the manufacture of the pipe, and, without notice to the manufacturer, shall also have the right to witness the manufacture of the pipe and any tests being performed by the manufacturer or his suppliers relative to products, materials, or the pipe being produced. Copies of records of tests and inspections shall be submitted if requested by the Engineer.

a. Pipes: These shall be manufactured and tested in accordance with ASTM D 3262.
b. Joints: Coupling joints shall meet the requirements of ASTM D 4161 and/or produce a zero leakage joint.
c. Stiffness: Minimum pipe stiffness when tested in accordance with ASTM D 2412 shall be 46 psi.

9. Fittings and Special Pipe: Fittings shall be contact molded or manufactured from mitered sections of pipe joined by glass-fiber-reinforced overlays, all capable of withstanding all operating conditions when installed.

10. Curves of long radius shall be formed by the use of bevel end pipe or by the use of bevel adapters. Deflection of pipe joints to form the long radius curves will not be accepted. Special pipes shall be designed to provide the same strength as the adjacent pipe. Branch connections or openings, such as manholes and bypass pumping connections, shall be incorporated in straight pipe and shall be suitably reinforced. Special pipes shall be provided with joints corresponding to those on adjoining straight pipes. Special ends shall be provided on pipe, where required, to connect to pipe of other manufacturers and special structures.

11. Unloading Handling and Storage: All pipe shall be inspected at time of delivery, and damaged pieces rejected and removed from the site of the work. Unloading shall be done by mechanical equipment designed to properly handle the pipe, and dropping from delivery vehicles will not be permitted. Pipe shall be stored in an orderly manner to protect the pipe from injury, and from damage by freezing, all in accordance with the manufacturer's written instructions.

M. High Density Polyethylene (HDPE) Pipe and Fittings

1. High Density Polyethylene Pipe (HDPE) may be used in construction of inverted siphons. No HDPE will be allowed in any other gravity sewer application. All HDPE shall be manufactured from virgin, extra high molecular weight, high density PE4710 polyethylene pipe grade resin to a minimum cell classification of PE445574C as determined by ASTM D3350. No post-consumer recycled polyethylene materials shall be allowed.

2. All HDPE pipe and fittings shall conform to ASTM F714 and ASTM D3261, respectively, and have a Standard Dimension Ratio (SDR) of 17, maximum.

3. Successive joints of HDPE pipe shall be joined by heat fusion at a fusion pressure of 75 psi and temperature of 400□ F. All such connections shall be performed in strict accordance with the manufacturer's instructions.

N. Polyvinyl Chloride (PVC) Pressure Pipe and Fittings

1. PVC pipe and couplings for force main applications will conform to the requirements of ASTM D 2241 and AWWA C 900 Standard for Polyvinyl Chloride (PVC) Pressure pipe 4 inches through 12 inches for Water. The minimum pressure class will be Class 100 or as specified and outside diameter base (IPS or CI) will be as specified in the Plans or Contract Documents.

2. Joints for pipe and couplings will be solid ring elastomeric gasket type. Gaskets must withstand internal pressures of not less than the minimum sustained pressure and burst pressure requirements specified for the pipe with which they are designed to be used. No solvent cement joints will be allowed. Joints will conform to the requirements of AWWA C 900 and/or ASTMD 2241.

O. High Density Polyethylene (HDPE) Pressure Pipe and Fittings

1. All HDPE shall be manufactured from virgin, extra high molecular weight, high density PE4710 polyethylene pipe grade resin to a minimum cell classification of PE445574C as determined by ASTM D3350. No post-consumer recycled polyethylene materials shall be allowed.

2. All HDPE pipe and fittings shall conform to ASTM F714 and ASTM D3261, respectively, and have a Standard Dimension Ratio (SDR) of 17, maximum.

3. Successive joints of HDPE pipe shall be joined by heat fusion at a fusion pressure of 75 psi and temperature of 400□ F. All such connections shall be performed in strict accordance with the manufacturer's instructions.

P. Air/Vacuum Valves, Automatic Air Release Valves and Combination Valves

1. The Air/Vacuum Valves shall be single body, double orifice and shall automatically exhaust air from the force main while being initially filled with fluid. After the air has been exhausted from the line, the valve shall close tightly. The valve shall remain closed as long as the sewer line is under positive pressure. Should the force main pressure fall below atmospheric pressure, the valve shall reopen to allow air to enter the pipe thereby preventing a negative pipe pressure. The valve shall be designed to prevent clogging due to solids in the fluid. Each of these valves shall be designed to separate the liquid from the sealing mechanism. The Air/Vacuum Valves shall be as manufactured by A.R.I. or approved equal.

2. The Combination Air Valve shall consist of a combination of an air and vacuum large orifice and an automatic small orifice in a single body. The valve must be designed to operate with liquids carrying solid particles. The valve shall discharge air during the filling or charging of the system and admit air to the system while being emptied of liquid and discharge accumulated air from the system while it's under pressure and operating. Each of these valves shall be designed to separate the liquid from the sealing mechanism. The valve shall have a working pressure range up to 150 psi or as specified on the plans. Combination Valves shall be A.R.I. or approved equal.

3. The manufacturer shall certify venting capacity and provide three copies of installation and maintenance manuals for each type of Combination Air Valve and Air/Vacuum Valve supplied.

4. The Manufacturer shall guarantee all items specified to be free from defects in design, materials and workmanship for one year from the date of acceptance. During the guarantee period, the Manufacturer shall furnish and install replacement parts for any defective component at no additional cost.

Q. Check Valves, Gate Valves and Ball Valves

1. All check valves shall have external arms so that the valve may be opened and closed by hand. Check valves shall be controlled closing swing check valves and shall be Golden-Anderson Series 250, or Valve and Primer Series 6000, or as approved. Each check valve shall have a cast iron body, stainless steel plates, stainless steel springs, stainless steel hinge pins and stops, Teflon spring and hinge bearings and standard trim for IBBM construction. All wetted components shall be 316 stainless steel. Each check valve shall have Buna N seals.

2. All check valves shall be class 125 vertical or horizontal swing type with iron body and flanged ends.

3. Knife gate valves will be manufactured by Red Valve Company, Inc, Pittsburgh, PA; and shall be their Standard Flexgate, or approved equal. Knife gate valves must conform to AWWA C-504 requirements. The shaft shall be constructed of Type 304 stainless steel. The knife gate shall be Type 316 stainless steel. The valve seat shall be a resilient, mechanically retained, field replaceable, polytetraflouroethylene elastomer. The upper and lower bearings shall be self-lubricating Teflon. The valve shall be equipped with a handwheel.

4. Wedge gate valves will be resilient wedge gate valves as manufactured by Mueller Co., or approved equal. Wedge gate valves must conform to AWWA C 509 or AWWA C 515 and will be either series 2360 or series 2361.

5. All ball valves for 2 inch and 3 inch diameter fittings shall be full port, brass ball valves, shall be rated to 125 psi minimum, and shall meet the requirements of NSF/ANSI 61/8. Ball valves will have threaded connections and blowout proof stems. Ball valves will be Series FBV-3C as manufactured by Watts, or as approved.

6. Valve manufacturer shall furnish certification that each valve has been subjected to a hydrostatic water pressure twice the pressure class and that each valve is free of defects. The valve manufacturer shall guarantee all items specified to be free from defects in design, materials and workmanship for one year from the date of acceptance. The manufacturer shall, during the guarantee period, furnish and install replacement parts for any defective component at no additional cost.

R. Steel Casing Pipe

1. Casing pipe will conform to ASTM A 139. Minimum yield strength will be 35,000 psi. Wall thickness will meet the requirements of the latest revision of the American Railway Engineering Association Manual of Recommended Practice unless otherwise specified. Wall thickness will be:

Nominal Thickness Inches	Nominal Diameter Inches
0.188	Less than 14
0.219	14 and 16
0.250	18
0.281	20
0.312	22
0.344	24
0.375	26
0.406	28 and 30
0.438	32
0.469	34 and 36
0.500	38, 40, and 42

2. When casing is installed without a protective coating and is not cathodically protected, the wall thickness shown above will be increased to the nearest standard size that is a minimum of 0.063 inches greater than the thickness shown. This requirement does not apply to casing diameters less than 12 3/4 inches.

S. Lubricants for Prefabricated Pipe Gaskets

1. The lubricant used in jointing pipes fitted with flexible, rubber gaskets will be as recommended by the pipe manufacturer. Lubricants will be suitable for use at temperatures from 5□ to 120□ F(-15□C to 50□C). Containers will be labeled with the intended, compatible pipe material and the manufacturer's name.

T. Primers and Adhesives

1. All primers and solvents used with ABS Composite Sewer pipe will conform to ASTM D 2235 and will be applied as recommended by the manufacturer. For bonding PVC to PVC, solvent cement will conform to ASTM D 2564. For bonding PVC to ABS, solvent cement will conform to ASTM D 3138. Adhesives used to fasten flexible rubber or rubber gaskets will conform to the requirements of the gasket manufacturer.

U. Adapters and Couplings

1. At the direction of the Engineer, a connection of sanitary sewer pipes, 6 inches through 16 inches, of dissimilar material, different sizes or for the repair of sanitary sewer pipes of similar material may be made by means of an approved compression or mechanical connector or adapter. The gaskets for compression connectors or adapters will be manufactured of an approved preformed elastomeric material conforming to applicable sections of ASTM Standards C 425, C 564, C1173, D 3212, and D 5926. Mechanical couplings or adapters will have tightening clamps or devices made of 300 series stainless steel with a stainless steel shear ring and stainless steel hardware, as specified in ASTM A 240. If a stainless steel shear band is not used a concrete collar is required. Each connector and adapter will bear the manufacturer's name and required markings. Installation will be by the manufacturer's recommendations.

2. At the direction of the Engineer, a connection of sanitary sewer pipes (18 inches in diameter and larger) of dissimilar material, different sizes or for the repair of sanitary sewer pipes of similar material may be made in accordance with Specification Section 02530 Paragraph 3.09.C. Mechanical connectors meeting the above requirements may be used at the direction of the Engineer.

V. Portland Cement Concrete

1. Portland Cement Concrete will be of the class and dimensions shown on the Plans, or as directed by the Engineer. The classes of concrete are called Class A and Class C. Class A concrete is intended principally for concrete structures designed for high strength. Class C concrete is low strength concrete, intended principally for foundation stabilization, pipe cradles and encasement and other general-purpose uses. All portland cement, coarse aggregate, fine aggregate, water, air entraining agents and chemical admixtures, their proportioning, mixing, delivery, minimum strength, sampling and testing will be as specified in Specification Section 03050.

W. Crushed Limestone

1. Crushed limestone will be size No. 67 Coarse Aggregate meeting the requirements of the Tennessee DOT Standard Specifications for Road and Bridge Construction and the following gradation:

Total Percent by Dry Weight,
Passing Each Sieve (U.S. Standard)

Size No.	1"	3/4"	3/8"	No. 4	No. 8
67	100	90-100	20-55	0-10	0-5

2. Crushed limestone meeting the requirements of the Tennessee DOT Standard Specifications for Road and Bridge Construction, size No. 57 Coarse Aggregate will be used as directed by the Engineer or as shown on the plans. Size No. 57 Coarse Aggregate will meet the following gradation:

Total Percent by Dry Weight,
Passing Each Sieve (U.S. Standard)

Size No.	1-1/2"	1"	1/2"	No. 4	No. 8
57	100	95-100	25-60	0-10	0-5

X. Deleted

Y. Mortar

1. Mortar will be composed of one part portland cement, two parts masonry sand, hydrated lime not to exceed 10 percent of the cement used, and 4 parts water. All ingredients will be proportioned by measurements and not by estimating. All portland cement, sand, and water will be as specified in Specification Section 03050. All hydrated lime will be as specified by ASTM C 206.

2. The mortar will be hand mixed or machine mixed. In the preparation of hand mixed mortar, the sand, cement and hydrated lime will be thoroughly mixed in a clean, tight, mortar box until the mixture is of uniform color, after which water will be added. Machine mixed mortar will be prepared in an approved mixer and will be mixed not less than 1½ minutes. Mortar will be used within 30 minutes after mixing.

Z. Bracing Lumber

1. Lumber for tunnel bracing will be a minimum of 3 inches thick and made of bridge oak. All timbers will be of good quality, straight grained, and free from weakening knots and other defects. Bracing will be placed to form a structurally sound timber tunnel. The timber tunnel lining will remain in place after laying the pipe and backfilling.

AA. Pit Run Gravel

1. Pit run gravel will consist of one of the three gradations shown in the table below.

	Total Percent by Dry Weight, Passing Each Sieve (U.S. Standard)						
Size No.	2½"	2"	1½"	1"	3/8"	No.40	Clay *
1	100	95-100			35-65	10-30	1-12
2		100	95-100		40-65	10-30	1-12
3			100	90-100	45-65	10-35	2-12

*Clay content will be determined by the Hydrometer Test-AASHTO T 88. Clay content up to 15 percent may be used with the approval of the Engineer.

2. That portion passing the No. 40 sieve will be known as the binder. The binder aggregate will consist of hard durable particles of limestone or sound siliceous material. Shale aggregate or pipe clay binder will not be acceptable. The percent of silt will not exceed the percent of clay by more than 25 percent. If the binder material is insufficient to bond the aggregate a satisfactory binding material may be incorporated, as approved by the Engineer, so that the resultant mixture will comply with these Specifications. The mixing will be done uniformly, and blending of material on stockpiles or in the pits by bulldozers, clamshells, draglines, or similar equipment will not be permitted.

BB. Brick

1. All brick will conform to ASTM C 55 for Grade A. Unless otherwise approved by the Engineer, bricks will conform to the following dimensions:

	Depth (in)	Width (in)	Length (in)
Standard Size	2 1/4	3 3/4	8
Allowable Variation	+ 1/4	+ 1/4	+ ½

2. All brick will be new and whole, of uniform standard size and with straight and parallel edges and square corners. Bricks will be tough and strong and free from harmful cracks and flaws. Brick will be culled after delivery if required and all culls will be removed from the work site.

3. The Contractor may be required to furnish the Engineer with at least five bricks of the character and make he proposes to use, at least one week before any bricks are delivered for use. All brick will be of the same quality as the accepted samples.

CC. Non-Shrinking Grout

1. Grout will be mixed in small quantities as needed and will not be re-tempered or used after it has begun to set. Unless otherwise specified, the grout will consist of one-part portland cement, two parts masonry sand by volume, a non-shrinking, nonmetallic admixture and sufficient water to form a grout of proper consistency. When non-shrinking or non-shrinking fast setting grout is specified it will be formulated by the incorporation of an admixture, or a premixed grout may be used.

2. The formulation, admixture or the premixed grout used will be subject to the approval of the Engineer and will be mixed and used according to the recommendations of the manufacturer. These special grouts will be classified as follows:

Type I – Non-shrinking Grout
Type II – Non-shrinking, Fast Setting Grout

Portland cement, masonry sand, and water will conform to the requirements of Specification Section 03050.

DD. Polyvinyl Chloride (PVC) Protective Lining for Concrete Pipe and Structures

1. Liner shall be Ameron T-Lock as manufactured by Ameron Protective Coatings Division, Brea, California or approved equivalent.

2. The material used in the liner and in all joint, corner, and welding strips shall be a combination of polyvinyl chloride resin, pigments, and plasticizers, specially compounded to remain flexible. Material color shall be white.

3. Polyvinyl chloride resin shall constitute not less than 99 percent, by weight, of the resin used in the formulation. Copolymer resins will not be permitted.

4. Tensile specimens shall be prepared and tested in accordance with ASTM D412 using die B. Weight change specimens shall be 1-inch by 3-inch samples of the sheet thickness. Specimens may be taken from sheet and strip at any time prior to final acceptance of the work.

5. Liner plate locking extensions embedded in concrete shall withstand a test pull of at least 100 pounds per linear inch applied perpendicularly to the concrete surface for a period of one minute, without rupture of the locking extensions or withdrawal from embedment. This test shall be made at a temperature of 70-80□F inclusive.

6. All plastic liner plate sheets, including locking extensions, all joint, corner and welding strips shall be free of cracks, cleavages or other defects adversely affecting the protective characteristics of the material. The Engineer may authorize the repair of such defects by approved methods.

7. The lining shall have good impact resistance, shall be flexible and shall have an elongation sufficient to bridge up to 1/4-inch settling cracks, which may occur in the pipe or in the joint after installation, without damage to the lining.

8. The lining shall be repairable at any time during the life of the structure.

9. Liner shall be a minimum of 0.065 inches in thickness. Locking extensions (T-shaped) of the same material as that of the liner shall be integrally extruded with the sheet. Locking extensions shall be approximately 2.5 inches apart and shall be at least 0.375 inches high.

10. Sheets shall have transverse strap channels cut in the locking extensions so that the strap can be placed into and perpendicular to the locking extensions.

11. These channels shall be not less than 3/4 inch wide and not more than 1 1/4 inch wide and shall be cut so that a maximum 3/16 inch of the base of the locking extension remains in the base of the strap channel. Strap channels shall be provided at intervals of not less than 15 inches and no more than 20 inches center-to-center. The strap channels will not be cut through the final two locking extensions on each edge of the sheet.

12. Transverse flaps shall be provided at the ends of sheets for pipe. Locking extensions shall be removed from flaps so that a maximum of 1/64 inch of the base of the locking extension is left on the sheet.

13. Weld strips shall be approximately 1 inch wide with a minimum width of 7/8 inch. The edges of weld strips shall be beveled in the manufacturing process. Thickness of weld strip shall be a nominal 1/8 inch.

14. All sheets used shall be shop tested for pinholes using an electrical spark tester set at 20,000 volts minimum. Any holes shall be repaired and retested.

EE. Tracer Wire for Sewer Line and Force Mains

1. Tracer wire shall be installed along the length of all sewer pipes, service connections, manholes and stubs. All tracer wire shall have HDPE insulation intended for direct bury, green in color, and be suitable for wet or dry applications. All system components, including tracer wire, connectors, ground rods and access points, must be compatible.

2. Tracer wire shall be copper-clad steel 12-AWG, and must conform to ASTM B910/ B910M. Minimum brake load of tracer wire is 450 lb. in open cut and 1,150 lb. in directional drilling. Tracer wire for pipe bursting shall be copperhead with Extreme Strength 7x7 stranded 4,700 lb. break load. Conductor shall be annealed copper and meet or exceed all applicable ASTM standards, including ASTM B3 and ASTM B170.

3. Insulation shall be high density, high molecular weight, polyethylene (HDPE) with a minimum flexural strength of 120,000 psi and shall meet or exceed ASTM D790. Insulation shall be green in color with a minimum thickness for open cut, directional drilling, and pipe bursting of 30, 45, and 50 mils respectively.

4. Connector shall be specifically manufactured for use in underground tracer wire and shall be dielectric silicone filled to seal out moisture and corrosion, and shall be installed in a manner to prevent any uninsulated wire exposure. Non-locking, friction fit, twist on, or taped connectors are prohibited.

5. Grounding of tracer wire shall be achieved by using a 1.5-lb, drive-in, magnesium ground rod with a minimum 20-feet HDPE insulated copper-clad steel wire connected to the rod specifically manufactured for this purpose.

6. All two-terminal tracer wire access points must include a manually interruptible conductive/ connective link between the terminal for the tracer wire connection and the terminal for the ground rod wire connection. All at-grade access points shall include an encapsulated magnet molded into the top portion of the tube, to allow for detection by a ferrous metal detector. On both public and private properties, tracer wire shall terminate at an approved

at-grade, two-terminal access box near the sewer clean-out. For sewer lines over 500 linear feet without service laterals, tracer wire access must be provided utilizing an approved grade level/in-ground trace wire access box, located at the edge of the road right-of-way, and out of the roadway. The grade level/in-ground tracer wire access box shall be delineated using a minimum 48" polyethylene marker post, green in color. All at-grade access points shall be supplied with anti-corrosion wax-gel to protect wires.

FF. Reserved

GG. New Material and Methods

1. The City encourages development of new products and technology and will consider the use of products or methods not previously specified. Product submittals will be reviewed by the City Engineer and a determination will be made as to the acceptability of the product. Consideration or review of a new product does not mean the City will accept its use on the Project.

2.02 EQUIPMENT

A. The Contractor will furnish and maintain in good condition all equipment and facilities as required for the proper execution and inspection of the Work. All equipment and facilities will be on site and approved by the Engineer before work will be permitted to begin.

PART 3 - CONSTRUCTION REQUIREMENTS

3.01 SITE PREPARATION AND RESTORATION

A. Rights-of-Way and Easements

1. Rights-of-way and/or easements as shown on the Plans and/or rights-of-way/easement plats are provided by the City to the Contractor for construction of sanitary sewer facilities. The Contractor will confine his construction activities to these areas. The Contractor will be responsible for obtaining written agreements for use of private property outside City acquired rights-of-way/easements for such purposes as storage of material and equipment and access to the construction site. The Contractor will immediately provide a copy of all such written agreements to the City upon obtaining the same.

B. Clearing of Rights-of-Way and Easements

1. The Contractor will confine his clearing of rights-of-way and easements to the least area necessary for construction of facilities shown on the Plans. The Contractor will protect as many trees and shrubs within the area as possible. Where necessary for construction the Contractor will clear all live and dead vegetation and growth, pole stubs, logs, and other objectionable material. Cleared material will be removed to within 3 inches of existing ground. This work will be done well before excavation operations but only after erosion controls have been placed.

C. Location of Existing Obstructions

1. Locations of obstructions shown on the Plans are approximate and are not intended as an accurate location of such obstructions. Obstructions not shown on the Plans but encountered by the Contractor will be removed and replaced in their original state or protected by the Contractor at no additional cost to the City.

D. Removal of Obstructions

1. The Contractor will demolish and remove all structures and structure foundations, abandoned vehicles, appliances, and rubbish within the right-of-way/easement limits necessary for the performance of the work.

E. Protection of Obstructions Outside Easement Limits

1. The Contractor will protect and avoid damage to all trees, shrubs, plants, fences, structures, and all other objects outside the right-of-way/easement limits shown on the Plans and/or Plats due to construction operations. All damage will be repaired or restored at the Contractor's expense. Particular attention will be paid to avoid damage to trees, shrubs, bushes, and private property located next to rights-of-way/easements. No trees, plants, or other objects may be removed outside such limits without written permission of the property owner.

F. Special Protection of Obstructions Inside Easement Limits

1. Wherever the underground installation of sanitary sewer facilities will go through surface improvements previously made by the City, other governmental bodies, or property owners, the Contractor will be responsible for their protection and preservation. This responsibility includes the removal and storage of such improvements to allow replacement and restoration as close as possible to the undisturbed condition.

G. Disposal of Debris

1. All trees, brush, logs, snags, leaves, sawdust, bark, and refuse will be collected and disposed of according to the City Code of Ordinances at the expense of the Contractor. There will be no separate pay item for disposal of debris. Debris will be removed from the site when practical and will not be left until the completion of the contract. If burning of debris is allowed by the Engineer all precautions will be exercised to prevent the spread of fire and such burning will be according Specification Section 01740 Paragraph 1.06. Burning will be done only at approved locations and in conformity with the laws, ordinances and requirements of agencies and officials having jurisdiction. Besides obtaining the permission of the Engineer, the Contractor will obtain and pay for any permits required. When material is to be disposed of outside the easement, the Contractor will first obtain written permission from the property owner on whose property the disposal is to be made and will file a copy with the Engineer. Unless otherwise provided in the Contract Documents, the Contractor will arrange for disposing of such material outside the right-of-way/easement. No debris will be deposited in wetlands.

2. As approved by the Engineer, wood chips, mulch, etc. placed by the Contractor to prevent soil erosion are not considered debris. All erosion prevention materials will be placed and maintained in accordance with the Memphis and Shelby County *Storm Water Management Manual* and/or the Tennessee Department of Environment and Conservation *Erosion and Sediment Control Handbook*.

H. Replacement of Fences

1. Any fences disturbed inside the right-of-way/easement limits will be replaced or restored to their original or better condition. Any fences removed will be replaced in their original location. Fences in such poor condition that they cannot be taken down and rebuilt with the same material will be replaced with new fence material similar in original quality, size, and appearance to the removed fence. Exceptions to this requirement will be allowed if written releases are obtained from the property owners by the Contractor and submitted to the Engineer. For chain link fence, new fence material and construction methods will conform to the requirements of Specification Section 02820.

I. Restoration of Turfed Areas

1. All areas will be restored as nearly as practicable to their original condition. Finished lawn areas where soil has been deposited will be cleared to the level of the existing sod and then raked and watered. Areas where sod has been damaged, destroyed, or ruts have been filled will be resodded. Areas where sod is only slightly damaged may be reseeded if so permitted by the Engineer. After final restoration of the settled trench surfaces, trench areas and areas regraded as part of the construction will be resodded, unless otherwise shown on the Plans or directed by the Engineer. Seeding and sodding material and construction methods will conform to the requirements of Specification Sections 02920 and 02921.

3.02 EXCAVATION

A. All excavation performed under this Section including trench excavation, structure excavation, and channel excavation, but excluding undercut excavation, will be considered unclassified excavation despite the nature of the material and objects excavated and will not be measured or paid for separately except as specifically noted. Pavement removal and replacement will be accomplished as specified in Specification Section 02950.

B. Trench Excavation

1. All trenches will be open cut unless otherwise shown on the Plans. Tunneling, boring, or jacking may be allowed by written permission of the Engineer.

2. Trenches may be excavated by machinery to a depth that will not disturb the finished subgrade. The remaining material will be hand excavated so that the pipe is bedded on a firm, undisturbed subgrade.

3. No more than 300 feet of trench will be opened ahead of the completed sanitary sewer, nor will more than 100 feet be left unfilled except by written permission from the Engineer. In special cases the Engineer may limit the distance to which the trench may be opened by notifying the Contractor in writing.

4. The width of trenches below a level 1 foot above the outside top of pipe will be at least 6 inches but not more than 12 inches on each side of the outside of the pipe for all sizes up to and including 16 inches in diameter. A maximum trench width dimension for these pipe sizes will be 36 inches. For 18-inch diameter pipes, the width of trenches below a level 1 foot above the outside top of pipes will be at least 6 inches on each side of the pipe, with a maximum trench width of 42 inches. For pipe sizes more than 18 inches, the width of trenches below a level 1 foot above the outside top of the pipe will be at least 12 inches but no more than 15 inches on each side of the outside of the pipe. If the trench width at or below 1 foot above the top of pipe exceeds the width specified, provisions will be made at the Contractor's expense to compensate for the additional load upon the pipe.

5. The sides of the trench will be as nearly vertical as possible. The bottom of the trench will be carefully graded, formed, and aligned according to City of Memphis Standard SST-3 and to the satisfaction of the Engineer before sanitary sewers are laid.

C. Other Excavation

1. Undercut Excavation:
Undercut excavation will consist of removing and disposing of unsatisfactory material below the grade established on the Plans for sanitary sewers, structures, and manholes. No undercut excavation will be done without prior authorization of the Engineer. The limits of undercut excavation will be determined by the Engineer who will be present during the undercut operations.

2. Undercut areas will be backfilled with No. 67 limestone or other aggregate approved by the Engineer to the grade established on the Plans. The backfill will be placed in 6 inch maximum lifts and compacted to 95 percent of maximum density at plus or minus 2 percent of optimum moisture content as determined by Laboratory Standard Proctor Test (ASTM D 698) or a minimum relative density of 0.75. Undercut backfill will be encapsulated in geotextile fabric conforming to Specification Section 02370 2.01.C.

3. Unauthorized Excavation Below Subgrade or Outside Limits:
Any unauthorized excavation and subsequent removal and backfilling beyond the lines and grades shown on the plans will be at the Contractor's expense. The excess space between the undisturbed bottom and sides of the excavation and subgrade limits shown on the Plans will be backfilled according to Specification Section 02530 Paragraph 3.02.C.2.

D. Change in Location and Grade

1. If the Engineer orders in writing that the location or grade of a proposed sanitary sewer facility be changed from that shown on the Plans, the following provisions will apply. If the change is made before excavation work has begun and the item being constructed is covered in the Proposal Sheet(s) by pay items with appropriate depth classifications, the appropriate pay item will apply. If the facility being constructed is not covered in the Proposal Sheet(s) and if the average excavation per linear foot at the changed location or grade is within 10 percent of the original Plan quantity, there will be no change in the unit price for this work. If the average excavation per linear foot at the changed location varies more than 10 percent above or below original Plan quantities, a Change Order will be prepared to cover the new work. For purposes of comparing changed quantities with Plan quantities, a 1-foot long strip will be calculated from natural ground line to invert along both the revised and original locations. These calculations will then be multiplied by the proper lengths to determine the total cost.

2. If the change is made after excavation has already begun on the original Plan location, the procedures described above will apply to payment for work along the changed location. If abandonment of an existing excavation is required due to a change by the Engineer, a Change Order will be prepared covering the backfilling and restoration of the abandoned excavation. Backfilling and restoration of the abandoned excavation will be accomplished according to the appropriate section of these Specifications.

3. Filling a portion of existing excavation to meet changed grades will be accomplished according to Specification Section 02530 Paragraph 3.11.

4. If a change in a location and/or grade is authorized in writing by the Engineer at the written request of the Contractor, the Contractor will not receive any additional compensation for the changed work. Backfilling and restoration of abandoned excavation work will be accomplished totally at the Contractor's expense. If changes requested by the Contractor result in reduced lengths and/or depth of excavation, the revised quantities using Proposal unit prices or Change Orders as appropriate will be used to develop payment.

E. Disposition of Excavated Material

1. Excavated material suitable for backfill will be stored no closer than 2 feet from the edge of the excavation. Excavated material will not obstruct crosswalks, sidewalks, driveways, street intersections, nor interfere unreasonably with travel on streets. Gutters or other surface drainage facilities will not be obstructed. The Contractor must provide access to fire hydrants, mail boxes, sewer and conduit manholes and similar utility or municipal service facility as required. Excavated material intended for backfill will be stored in a way that minimizes loss of excavated material due to erosion. The Contractor shall comply with all applicable OSHA regulations and City of Memphis Storm Water Ordinances.

2. Unless otherwise directed, all excavated material that will not be used for backfilling or restoration will be removed from the site and disposed of by the Contractor. If the Contractor proposes to store or place such excess excavated material upon any private property, written consent of the property owner or owners must be obtained by the Contractor in advance. A

certified copy will be given to the Engineer. No surplus or excess material will be deposited in any stream channel nor anywhere that would change preconstruction surface drainage.

F. Control of Water

1. The Contractor will keep all excavations free of water. If the trench subgrade consists of good soil in good condition at the time of excavation, it will be the Contractor's responsibility to maintain it in suitable condition. Dams, flumes, channels, sumps, or other work and equipment necessary to keep the excavation clear of water will be provided by the contractor. Dewatering of trenches, will be incidental to trench excavation. The Contractor will avoid producing mud in the trench bottom by his operations. If necessary or so ordered by the Engineer, the Contractor will remove any soil that becomes unacceptable and replace it with limestone or other approved aggregate at his own expense to maintain a firm, dry base.

2. Pipe bedding, laying, jointing, and the placing of concrete or masonry will be done in a water free trench or excavation. Trenches will be kept clear of water until pipe joints, concrete and masonry have set and are resistant to water damage. The water will be disposed of in a manner acceptable to the Engineer.

3. All gutters, pipes, drains, conduits, culverts, catch basins, storm water inlets, ditches, creeks, and other storm water facilities will be kept in operation, or their flows will be satisfactorily diverted and provided for during construction. Any facilities disturbed during construction will be restored to the satisfaction of the Engineer.

G. Excavation Around Obstructions

1. The Contractor will perform all excavation by hand where excavation by machinery would endanger trees, structures, or utilities that otherwise might be saved by hand excavation.

2. The Contractor will cautiously excavate test holes to find the limits of underground obstructions anticipated within the excavation. When a water pipe, gas pipe, other sanitary sewer, storm drain, or similar utility comes within the limits of the trench, such facilities will be properly supported.

H. Excavation for Manholes and Special Structures

1. The Contractor will be responsible for performing the Work according to the lines and elevations shown on the Plans or as directed by the Engineer. The Contractor will excavate as required for all structures with foundations carried to firm, undisturbed earth at the elevation of the underside of the structure.

2. The outside dimensions of excavations for manholes and special structure will be at least 12 inches greater than the outside of the masonry or concrete work to permit backfilling around the structure.

3. Where structures are to be built in street rights-of-way or paved areas, the excavation will not exceed 2 feet from the outside of the masonry or concrete work. If the excavation exceeds this limit, the Contractor will be required to backfill the entire space around the structure with pit run gravel compacted as specified in Specification Section 02530 Paragraph 3.11.B.

I. Special Protection

1. Treacherous Ground:
When running sand, quicksand, or other treacherous ground is encountered, the work will be

carried on with the utmost urgency and will continue day and night should the Engineer so direct.

2. Sheeting and Shoring:
The Contractor will furnish, place, and maintain sheeting and shoring as required to support the sides of any excavation to prevent earth movement that could endanger the workers or public and to prevent damage to the excavation, adjacent utilities or property. The Contractor will place the sheeting and shoring without the Engineer's instructions.

3. Sheeting will extend below structure invert a sufficient depth to assure adequate support. In the installation of sheeting, the use of vibratory type pile drivers (as opposed to impact type) will be limited to sheeting driven no greater than 5 feet below the invert. The sheeted trench width, as measured between those faces of the sheeting in contact with the earth trench wall, will not exceed the maximum width of a trench per Specification Section 02530 Paragraph 3.02.B. Walers and struts will be designed and installed to present no obstructions to proper placement of the pipe, bedding, cradle or encasement, and they will not interfere with the satisfactory installation of the pipe.

4. Sheeting, bracing, and shoring will be withdrawn and removed as the backfilling is being done, except where the Engineer permits the material to be left in place. The Contractor will cut off sheeting left in place at least 2 feet below the surface and will remove the cut off material from the excavation.

5. All sheeting, bracing, and shoring which is not left in place under this provision will be removed in a way that will not endanger the completed work or other structures, utilities, storm drains, sewers, or property. The Contractor will be careful to prevent the opening of voids during the extraction process.

6. If sheeting and shoring are not specifically required on the Plans or in the Specifications, steel drag shields or trench boxes may be used subject to the authorization of the Engineer. Voids left by the advancement of the shield will be carefully backfilled and compacted following trench backfill requirements.

7. Excess Width of Trench:
If the Contractor is permitted to use equipment that results in wider trenches than specified, approved methods will be used around the pipe to resist the additional load caused by the extra width. The dimensions of the cradle or other methods will be specified by the Engineer. The contractor is responsible for meeting all applicable OSHA requirements. No extra compensation will be allowed for the additional material or work. Excess width trenches for semi-rigid and flexible pipe will be backfilled and compacted according to ASTM D 2321, and no concrete cradle will be used.

8. Blasting:
Blasting will be undertaken only after the Contractor has received written authorization from the Engineer. With respect to the use of explosives in blasting, the Contractor will obtain all necessary permits and comply with all laws, rules, and regulations of the federal, state, City, and the insurer governing the keeping, storage, use, manufacture, sale, handling, transportation, or other disposition of explosives. The Contractor will obtain additional insurance covering the use of explosives with limits and coverage as specified by the Engineer. All operations involving the handling, storage, and use of explosives will be conducted with every precaution under the supervision of a properly licensed individual. The Contractor will take special precautions for the proper use of explosives to prevent harm to human life and damage to surface structures, utilities, storm drains, sewers, or other subsurface structures. The Contractor will advise the Engineer in advance when charges are to be detonated. Blasts will not be fired until all persons in the vicinity have had ample notice and have reached positions of safety.

9. Sanitary sewer construction will be carefully protected from all blasts, and all excavations requiring blasting will be fully completed at least 30 feet ahead of the laying of the pipe. The mouth of the pipe will always be covered with a board or other plug carefully fitted to the pipe to prevent earth or other substances from entering.

10. After a blast is fired, the Contractor will thoroughly scale the excavation. All loose, shattered rock or other loose material that may be dangerous to the workers, pipe, or structure will be removed and the excavation made safe before proceeding with the work. The fact that the removal of loose, shattered rock or other loose material may enlarge the excavation beyond the required width will not relieve the Contractor from making such removal and filling the extra space. The Contractor will not be entitled to extra compensation therefore.

11. Underpinning:
When excavations require underpinning of existing structures, the Contractor will submit shop drawings of underpinning details to the Engineer for review before commencement of excavation below the foundation of the structure. Review of underpinning details by the Engineer will not relieve the Contractor of his responsibilityfor protection of the structure and its contents.

J. Existing Utilities

1. Location:
The Plans show the readily available record of location of existing structures and facilities both above and below the ground, but the City assumes no responsibility for the accuracy or completeness of this information. Utility service connections are not shown on the Plans, but can be expected in built-up areas, and if relocating them is necessary, it will be the Contractor's responsibility to arrange for the relocation with the owner or owners of theutilities.

2. Protection
The Contractor will protect any storm drain, sewer, or utility within the limits of the construction. The Contractor will proceed with caution and will use every means to establish the exact location of underground structures and facilities before excavating in the vicinity. The City will not be responsible for the cost of protection or repair or replacement of any structure, pipe line, conduit, service connection, or similar facility broken or damaged by the Contractor's operations. All water and gas pipes and other conduits near or crossing the excavation will be properly supported and protected by the Contractor.

3. If the construction requires the removal and replacement of any overhead wires or poles, underground pipes, conduits, structures or other facilities, the Contractor will arrange for such work with the Owner or Owners of the facilities. No additional payment will be made by the City for this work.

4. Service Connections:
Sewer and utility services between mains and buildings will be maintained and adjusted as necessary by the Contractor to provide as nearly a continuous operation as can be expected. This will be accomplished in any way that the Contractor chooses, provided the individual service is not interrupted for more than two consecutive hours. The occupants will be notified by the Contractor at least six hours before such service interruptions. When a break occurs, the Contractor will notify the affected occupant(s) of the probable length of time that the service will be interrupted.

5. If existing underground facilities or utilities require removal and replacement for the performance of this work, all replacements will be made with new material conforming to the requirements of these Specifications. If not specified, the material will be as approved by the Owner.

6. The removal and replacement of water services to adapt to new construction will be the

Contractor's responsibility within the limits where the new service line grade blends smoothly with the existing service line grade.

7. The removal and replacement of sewer house connections to adapt to new construction will be the Contractor's responsibility from the sewer main to a point where the new grade and existing grade can be matched.

8. The Contractor will be responsible for any damage to the sewer house connection because of his operations. The Engineer does not guarantee the number, size, condition, nor length of adjustment necessary to bring a service to a new grade.

3.03 SEWER PIPE INSTALLATION

A. General

1. Sewer pipe and bedding will be constructed as shown on the Plans. It will be the Contractor's responsibility to find all underground utilities before construction to insure there are no conflicts with the proposed line and grade. The Contractor's surveyor shall verify the base information on the City's plans prior to commencement of construction. Any discrepancies in the plans shall be reported to the Engineer immediately. If approved by the Engineer, minor changes in the alignment or grade will be permitted to avoid underground facilities, if straight alignment can be maintained between manholes. If minor changes in line or grade cannot avoid a conflict with the existing utility, the Contractor will arrange with the owner of said utility to have it adjusted as required to accommodate the proposed sewer at no additional expense to the City.

B. Modifications of Existing Sanitary Sewer Facilities

1. Maintenance of Flow:
Where existing sewer lines are being modified, the Contractor will arrange his work so that sewage flow will be maintained during the construction period with no discharge of sewage into the open trench, and no back up of sewage in the existing line. The contractor will provide necessary bypass pumping capacity to carry flow downstream of the section to be modified.

2. Abandonment of Sewer Pipe:
Sewer pipe called for in the Specifications or Plans to be abandoned will be sealed at each end for a minimum distance of 18 inches, or one-half the diameter of the pipe, whichever is greater. Unless otherwise specified, the pipe will be sealed with a brick bulkhead and/or acceptable cement grout to form a solid watertight plug completely bonded to the pipe. Any sewer manholes to be abandoned will be abandoned per Specification Section 02531 Paragraph 3.03.B.

3. The Contractor will be allowed to remove pipe to be abandoned if wanted. If the Contractor elects the removal method, all associated costs will be included in the cost for other Pay items.

4. Connection to Existing Manholes:
The Contractor will core suitable openings into existing manholes or remove existing pipe to accommodate the sewer pipe at the proper elevation, location, and direction, as indicated on the Plans. Care will be used to avoid unnecessary damage to the existing manhole.

5. All loose material will be removed from the cut surfaces that will be completely coated with nonshrinking grout before setting the pipe. Before inserting the pipe, a sufficient thickness of grout will be placed at the bottom and sides of the opening for proper bedding of the pipe. For semi-rigid and flexible pipe installations a water stop as approved by the pipe supplier will be installed on the pipe according to the manufacturer's recommendations. After setting, all spaces around the pipe will be solidly filled with nonshrinking grout and neatly pointed up on the inside to present a smooth joint, flush with the inner wall surface. Any necessary revisions on the existing

manhole invert will be made to provide a smooth, plastered surface for properly channeled sewage flow from the new connection. Plaster on the exterior of brick manholes will be repaired with nonshrinking grout. Particular care will be given to ensure that the earth sub-base and bedding next to the manhole will provide firm solid support to the pipe.

6. Removal of Sewer Pipe:
Existing pipes and manholes to be removed and their locations will be shown on the Plans. Existing sewer pipe and manholes that must be removed to excavate for the proposed sewer will be included in the cost of the proposed sewer pipe and no additional compensation will be made to the Contractor. The City reserves the right to retain or reject salvage of any material encountered. All remaining material becomes the property of the Contractor who will be responsible for properly disposing of the same.

C. Tracer Wire Installation

Tracer Wire

1. Tracer wire must be installed per manufacturer recommendations, and all service lateral tracer wires properly connected to the mainline tracer wire, to ensure full tracing/locating capabilities from a single connection point. Lay mainline tracer wire continuously, by-passing around the outside of manholes/structures. Tracer wire must be fastened on all pipe (mainline and service connections) with plastic zip ties at 5-foot intervals. Tracer wire on all sanitary service laterals must terminate at an approved at-grade, two-terminal access box color coded green and located directly above the service lateral at the road right of way.
1. Service connection tracer wire shall be a single wire, connected to the mainline tracer wire using a lug connector, installed without cutting/splicing the mainline tracer wire.
2. New tracer wire being extended or tied into an existing tracer wire shall be connected using approved splice connectors, and shall be grounded at the splice location specified.
3. Tracer wire must be properly grounded at all dead-ends/stubs. Grounding of tracer wire shall be achieved by use of a drive-in magnesium grounding anode rod with a minimum of 20 feet of HDPE copper clad wire connected to anode specifically manufactured for this purpose, and buried at the same elevation as the sewer line.
4. In case of occurring damage to the wire during installation, an immediate repair is required by removing the damaged wire and installing a new section of wire with approved connectors.

Connectors

1. All mainline trace wires shall be interconnected at intersections, at mainline tees, and mainline crosses. At tees Direct bury wire connectors shall include 3-way lockable connectors and mainline to lateral lug connectors specifically manufactured for use in underground tracer installation. Connectors shall be dielectric silicon filled to seal out moisture and corrosion, and shall be installed in a manner to prevent any uninsulated wire exposure. Non-locking, friction fit, twist on, or taped connectors are prohibited.

3.04 PIPE BEDDING

A. Bedding will be defined as that material supporting, surrounding and extending to one foot above the top of the pipe. Bedding for sewer pipe will conform to the requirements given below for Class A, B.1, or B.2, whichever is shown on the Plans. If the class of bedding is not shown, a minimum of Class B.1 or B.2 bedding will be provided as specified below. At the direction of the engineer or as shown on the plans, sewer pipe and Class B.1 or B.2 bedding will be encapsulated in geotextile fabric as specified in Section 02370 2.01.C.

B. Class A - Concrete Cradle

1. Class A bedding for sewer pipe will consist of a continuous concrete cradle constructed in conformity with the details shown on the plans or as directed by the Engineer. Class A bedding will only be used for rigid pipe.

C. Class B.1-Crushed Limestone

1. Class B.1 bedding will be number 67 crushed limestone. Pipe 4 inches to 24 inches in diameter will be bedded on 4 inches of bedding material. Pipe 27 inches to 48 inches in diameter will be bedded on 6 inches of bedding material. Bedding for pipes larger than 48 inches in diameter will be by design based on anticipated soil conditions. After pipe installation, crushed limestone will then be tamped under the haunches continuing in layers not more than 6 inches in loose thickness around the pipe to the spring line. The remainder of the installation will be as outlined in Specification Section 02530 Paragraph 3.11. Unless otherwise instructed, concrete and ductile iron pipe will be bedded in Class B.1 bedding.

D. Class B.2-Crushed Limestone

1. Class B.2 bedding will be number 67 crushed limestone. Pipe 4 inches to 24 inches in diameter will be bedded on 4 inches of number 67 crushed limestone Pipe 27 inches to 48 inches in diameter will be bedded on 6 inches of bedding material. Bedding for pipes larger than 48 inches in diameter will be by design based on anticipated soil conditions. After pipe installation, crushed limestone will then be tamped under the haunches and continued in layers not more than 6 inches in loose thickness around and above the pipe to a level 6 inches above the outside top of the pipe. The remainder of the installation will be as outlined in Specification 02530 Paragraph 3.11. Class B.2 bedding will be used for all flexible pipe including fiberglass reinforced polymer mortar pipe, PVC and HDPE.

E. Deleted

3.05 PIPE LAYING

A. Inspection Before Laying

1. All pipe will be inspected on delivery. Pipe that does not conform to the requirements of these Specifications or is not suitable for use will be rejected and immediately removed from the work site.

B. Preparation of Pipe Ends

1. All surfaces of the pipe to be joined will be clean and dry. All necessary lubricants, primer, adhesives, and similar material will be used as recommended by the pipe or joint manufacturer's specifications.

C. Care During Hoisting, Placing, And Pushing Home

1. Equipment used to handle, lay, and join pipe will be equipped and used as to prevent damage to the pipe. All pipe and fittings will be carefully handled and lowered into the trench. Damaged pipe or jointing material will not be installed.

D. Direction of Work

1. The laying of pipe will be commenced at the lowest point. The bell or grooved end will be laid upgrade. All pipe will be laid with ends abutting and true to line and grade. They will be carefully centered so that when laid they will form a sewer with a uniform invert.

E. Uniform Pipe Bearing

1. Special care will be taken to insure that the pipe is solidly and uniformly bedded, cradled, or encased according to the Plans. For pipe with a bell that is larger than the barrel of the pipe the bedding material will be removed to a depth that will provide continuous support for the bell and barrel. No pipe will be brought into position for joining until the preceding length has been bedded, joined, and secured in place. Where a concrete cradle is required, the pipe will be supported at no more than two places with masonry supports of minimum size sufficient to provide the required clearance and to prevent displacement during placing of concrete.

F. Alignment and Grade

1. Each piece of pipe will be checked for vertical and horizontal alignment immediately after being laid. All adjustments to alignment and grade must be made by scraping away or filling in under the barrel of the pipe and not by wedging or blocking up any portion of the pipe or striking the pipe to drive it down. Curved alignments will not be allowed except as directed by the Engineer.

G. Backfilling to Secure Pipe

When the joint is made, sufficient backfill material will be simultaneously placed along each side of the pipe to prevent moving the pipe off line and grade. Particular care will be used to prevent disturbance or damage to the pipe and the joints during backfilling.

H. Flotation and Water in the Trench

1. The Contractor will take all necessary precautions to prevent flotation of the pipe in the trench. Water will not be allowed to rise in the trench. The Contractor will use well points, sump pumps, or another approved method of dewatering as required to lower the water table below the bottom of the excavation while minimizing the migration of fines from the surrounding area. The Contractor will make a request to the Engineer and receive approval prior to the use of special dewatering equipment other than well points or sump pumps. Dewatering operations are considered incidental to the work and no additional compensation will be made to the Contractor.

I. Open Ends

1. Whenever pipe laying is stopped for any significant length of time, such as at the end of a workday, the unfinished end will be protected from damage and a temporary tight fitting plug or bulkhead will be placed in the exposed ends of the pipe to keep soil or other debris from entering the pipe.

J. Concrete Cradle Section next to Manhole

1. The pipe will be supported from the manhole wall to the limits of the manhole excavation in a normal sewer trench with a concrete cradle, structurally continuous with the manhole base slab or footing. Cost for this work is incidental to the cost of the pipe installation.

K. Cutting Pipe

1. Cutting will be in a neat workmanlike manner at right angles to the pipe axis without damage to the pipe. Observe specifications regarding joint locations. Smooth the cut end by power grinding or filing to remove burrs and sharp edges. Repair lining of the pipe asrequired.

L. Wyes and Special Fittings

1. Wyes, stubs, reducers, fittings, or other special pipes will be installed as shown on the Plans or where ordered by the Engineer. The fittings and special pipes will be made of a compatible material, type, and class and/or strength designation as the pipe and installed as required by the Plans and Specifications. The cost for providing and installing the above items is incidental to the cost of the pipes.

M. Valves

1. Valves and appurtenant fittings will be installed as shown on the Plans or where directed by the Engineer.

2. Check valves and gate valves will be installed on either flanged or mechanical joint ductile iron pipe.

3. Air release, vacuum relief and combination air valves larger than 3 inches in diameter will be installed on either flanged or mechanical joint ductile iron pipe. A gate valve conforming to Specification Section 02530 2.01.Q shall be installed to isolate these air valves from the force main.

4. Air release, vacuum relief and combination air valves 3 inches in diameter and smaller will be installed on a ductile iron tap 'T' fitting. A ball valve conforming to Specification Section 02530 2.01.Q shall be installed on a 6" threaded nipple between the 'T' and the air valve.

3.06 PIPE JOINTS

A. General

1. Pipe will be jointed immediately following the laying of each section. No pipe section will be left overnight which has not been completely jointed to the preceding pipe section in conformance with these Specifications.

2. The following provisions will apply to insure tight and sound joints:

a. The joint will be placed with special care to avoid breaking joints and to leave gasket, if required, in proper position.

b. All pipe 12 inches in diameter or larger will have dead weight held by crane while being lined up and pushed home.

c. Pipe will be pushed home with a constant and even force and not jarred home by the momentum of a moving force that will place an impact load on pipe.

d. Cement and lubricant will be used as recommended by the manufacturer and designated by the Engineer.

B. Compression Joints

1. The two ends to be joined will be thoroughly cleaned and a compression gasket compatible with the type of pipe to be joined will be at the position recommended by the pipe manufacturer.

2. Lubricant recommended by the gasket manufacturer will be liberally applied to the gasket and both ends immediately before pipe ends are joined. The upstream pipe will be positioned such that the spigot may enter the bell squarely. The pipe being laid will be pushed home and the gasket position checked with a feeler gauge before installation of the next section. Flat, unconfined gaskets on concrete pipe will be cemented to the spigot at the position recommended by the pipe manufacturer.

C. Mechanical Joints

1. The two ends to be joined will be thoroughly cleaned with a wire brush and the plain end, socket end, and gasket will be brushed with soapy water. The end will be centered in the socket and adequate anchorage will be provided to hold the pipe in position until the joint can be completed. When deflecting pipe from a straight line is necessary, the deflection will be made after joint assembly and before tightening bolts. Pipe deflection will not exceed that specified by ANSI C 600.

2. When tightening bolts, it is essential that the gland be brought up toward the pipe flange evenly, maintaining approximately the same distance between the gland and the face of the flange at all points around the socket. All bolts will be torqued to the required range recommended by the pipe manufacturer. Over stressing of bolts will be avoided. Gauge lines on the spigot end will be checked following assembly to ensure proper positioning of bell and spigot has been accomplished.

3. Any joints not properly positioned will be disassembled, cleaned, and reassembled as previously indicated.

D. Flanged Joints

1. The two ends to be joined will be thoroughly cleaned with a wire brush. Bolt holes on each pipe flange to be joined will be aligned and bolts inserted. Bolts will be torqued evenly by alternating tightening of bolts opposite one another until all bolts are torqued to the recommended pressure.

E. Solvent Cement Joints

1. The two ends to be joined will be thoroughly cleaned and primer liberally applied to the outside of the spigot within the joint insertion limits and inside the bell in conformance with the manufacturer's recommendations. Cement will be applied immediately to the same surfaces as the primer and the pipe joined within one minute. A sufficient quantity of cement will be applied to form a bead of excess cement around the full circumference of the joint when the spigot is fully inserted. The spigot end will be inserted to the insertion stop mark and rotated one-fourth turn. Avoid disturbing the joint until cement has had ample time to set.

F. Restrained Joints

1. Restrained push-on joints are to be used as specified on the plans or by the Engineer. These special joints will be installed as specified by the manufacturer. The length of the pipe to be restrained will be determined by the Engineer based on pipe size, internal pressure, depth of cover, and soil characteristics around the pipe.

3.07 PIPE CAPS AND PLUGS

A. Wyes, stubs, or other fittings installed in the pipe for future connections will be closed at the open end. For pipes 21 inches in diameter or smaller, an approved cap or plug will be installed in the bell or socket using the same type joint or jointing material as required for the sewer. For pipes larger than 21 inches in diameter, temporary approved masonry bulkheads of the thickness required by the Plans and Specifications to close the open end may be substituted for stoppers. Care in backfilling will be used so that such closure and its seal will not be disturbed. This stopper will be jointed so that it may be removed later without injury to the pipe itself. Work and material is incidental to the cost of the pipe installation.

3.08 SERVICE CONNECTIONS

A. All service connections on new pipe up to and including 12-inch diameter will be 6-inch diameter either Schedule 40 or SDR 26 in-line wye connections unless indicated otherwise on the Plans. Service connections on pipes larger than 12 inches in diameter will not be allowed. Saddles will not be used on new construction.

B. All service connections on existing pipe up to and including 12-inch diameter will be 6 inch diameter Inserta Tee, or approved equal, or saddle wye connections.

C. Although the general location of connections may be shown on the drawings, the actual location will be determined by the Contractor, subject to approval by the Engineer. Connections for undeveloped property will generally be at the center of the lot. Connection locations for developed property will be coordinated with the property owner. The quantities shown on the proposal sheet are only approximate and are subject to change. The depth of connections at the property line will be determined by the Engineer. Service connections will be laid on no less than a 1 percent grade for 6-inch diameter connections unless otherwise directed by the Engineer. Each building connection will be accurately recorded by station offset and depth on the as-built drawings and will be furnished to the Engineer. Unless authorized by the Engineer in writing, or shown on the drawings, building connections will not be tied into new or existing manholes. When service connections are tied into manholes at an elevation greater than 2 feet above the manhole invert, the service will be constructed as a drop construction as specified in Specification Section 02531 Paragraph 3.08.

D. Service connections will be laid in open trenches except where tunneling may be necessary under existing curbs, sidewalks, or pavements. In all such instances, a shaft must be excavated at the end of the connection for inspection purposes and measurement of length and depth. All service connections will extend to the right-of-way or easement limits. The service connection will be installed in conformance to the City of Memphis Standard No. SST-16.

3.09 PIPE ENCASEMENT, COLLARS, AND THRUST BLOCKS

A. General

1. Concrete will be Class "C" Concrete as specified in Specification Section 03050. All concrete will be placed, cured, and protected according to the applicable paragraphs of Specification Sections 03050 and 03310. Pipe alignment will be inspected immediately following concrete placement and any misalignment caused by the placement of concrete will be corrected before the initial set. Concrete will be protected against water until completely cured.

B. Pipe Encasement

1. Concrete encasement for pipes is to be used at the locations shown on the Plans or as directed by the Engineer. Concrete will be Class C and will be reinforced as required. All pipe requiring encasement will be blocked at each joint using masonry supports of a minimum size sufficient to provide the required clearance and to prevent displacement during placing of concrete. Concrete will be placed on either side of the pipe in approximately equal amounts to prevent movement of the pipe. Concrete encasement is to be rectangular in section with a thickness of ½ the pipe diameter between the outside edge of pipe and the outside of encasement at the closest point unless shown otherwise on the Plans. The absolute minimum thickness for concrete encasement shall be 6 inches regardless of pipe size.

C. Pipe Collars

1. Concrete pipe collars are to be used to join pipe ends that cannot be joined with prefabricated joints. Concrete will be Class C and will be reinforced when shown on the Plans. Concrete pipe collars will be constructed at the locations and to the dimensions shown on the Plans or as directed by the Engineer. Pipes being joined will be blocked and supported laterally to prevent movement during placing or curing of concrete. Rubber water stops will be placed on each pipe before pouring the concrete collar. Fernco or equal mechanical coupling will be used for pipe connectors 16 inches and smaller.

D. Thrust Blocks

1. Concrete thrust blocks are to be used to resist internal thrust pressures at bends and fittings in force mains at the locations shown on the Plans or as directed by the Engineer. Concrete will be Class C and will be reinforced when shown on the Plans. Thrust blocks will conform to the dimensions shown on the Plans or City of Memphis Standard SST-12. Load distribution type thrust blocks will be poured continuously from the force main to the undisturbed trench face. Backfill will not be placed as backing material for load distribution type thrust blocks.

2. All concrete will be poured in a way that leaves the pipe joint accessible for caulking or tightening of bolts. Care will be taken to permit the concrete to cure long enough to develop sufficient strength before the concrete is required to withstand the thrust. The area of the concrete bearing on the main or the restraining mass must be large enough to prevent over stressing the concrete.

3. If a concrete mass is used, a form may be necessary to contain the mass to provide access to joints or to insure the required bearing area. Generally, some form work is required for the mass of concrete necessary for blocking on mains sized 12 inches and larger. In poor soil, forming the concrete mass to construct the necessary bearing surface will be necessary. Instead of this construction, a restrained joint may be used.

4. Thrust blocks will be included in the linear foot price for the force main.

3.10 INVERTED SIPHONS

A. Each siphon will include inlet, outlet, and any intermediate manholes where shown on the Plans with all foundations, pipes, and pipe encasement and other appurtenances. Pipe to be included in the cost of the siphon is to be all pipe, fittings and specials between the center of the inlet manhole and the center of the outlet manhole.

B. The Contractor will construct cofferdams, temporary bulkheads, perform all pumping and other work necessary to protect the siphon during construction. The Contractor will be required to maintain a dry trench during construction, and will never be permitted to lay pipe or place concrete with water in the trench. Trenches will be kept free from water until the material in the joints and masonry has sufficiently hardened per Specification Section 02530 3.02 F Control of Water

C. Unless otherwise specified, inverted siphon pipe will be lined ductile iron Class 50 pipe and fittings as specified in Specification Section 02530 Paragraph 2.01.H fabricated for push-on type joints or HDPE conforming to Specification Section 02530 Paragraph 2.01.M. The siphon pipes will be encased in concrete at the locations and to the dimensions shown on the Plans or Details. The excavation, bedding, laying, jointing, pipe encasement, and backfill operations will conform to the applicable sections of this Specification.

D. When shown on the Plans, flexible joint ductile iron pipe will be used instead of push-on joint pipe as shown on Design Standards. Flexible joint pipe will be laid such that the maximum joint deflection as specified by the pipe manufacturer for each joint is not exceeded.

E. The inlet, outlet, and any intermediate manholes will be constructed according to the requirements of Specification Section 02531.

F. The inlet and outlet manhole inverts will be carefully shaped to conform to the inlet and outlet pipes and cause the least possible resistance to flow. The inlet manhole will have an invert weir constructed to contain low flows to a single siphon pipe. The invert weir will be level across the top and constructed to the elevation shown on the Plans. The outlet manhole invert will be formed to reduce backflow into the inactive siphon pipes.

3.11 BACKFILLING

A. General

1. After sanitary sewer facilities have been bedded and installed according to these Specifications and upon permission of the Engineer, the backfill may be placed. Backfilling operations will continue following as closely behind pipe installation as practical. All backfill will be placed in uniform horizontal layers. Pushing backfill material down a ramp into excavated areas will not be permitted. No trash will be allowed to accumulate in the space to be backfilled. Particular care will be taken to avoid allowing wood to be included in the backfill, other than sheeting and shoring that has been approved to be left in place.

2. The Contractor will be responsible for the condition of the trenches and filled areas during the contract and warranty period. The Contractor will maintain frequent inspection of the same. Anytime during the 12-month warranty period the trenches or filled areas settle and sunken places appear, the Contractor will be required to refill these sunken places when they are discovered with suitable material and will replace all damaged curb, gutter, and sidewalk. All soft or dangerous trenches will be marked, barricaded and caution lighted for the protection of the public.

3. Property with an existing dwelling located on it or lots within a developed subdivision or planned development are considered improved property.

B. Street Right-of-Way and Improved Property

1. Backfill Material:

a. Backfill for manhole and pipe trench excavations through pavements in street or highway right-of-way or where the Engineer orders, will be made with pit run gravel or other acceptable material as approved by the Engineer. The backfill will be from the top of the bedding material or foundation to the subgrade elevation of the pavement. Pea gravel or similar granular material approximately uniform in size and without bonding properties will not be used.

b. Backfill for manhole and pipe trench excavations beyond pavements in street or highway right-of-way or outside public right-of-way will be made with select earth from the top level of the bedding material or foundation to the subgrade elevation in paved area, or within 1 inch of the surface in areas to be sodded, or to the surface in all other areas.

c. Select material will be free from debris, organic matter, perishable compressible material and contain no stones or lumps larger than 6 inches. Rocks and lumps smaller than 6 inches will not exceed an amount that will interfere with the consolidating properties of the fill material. Care will be taken that stones and lumps are kept separated and well distributed, and that all voids are completely filled with fine material. No rocks or lumps will come in direct contact with the pipe. The upper 3 feet of backfill in sodded or planted areas will be free of rocks or lumps larger than 1 inch in diameter.

2. Placement and Compaction:

a. Sanitary Sewer Trenches:
Backfill material will be placed by hand in 6 inch loose layers and tamped to a point 2 feet above the outside top of the pipe. Backfill will be compacted with suitable mechanical tamping equipment with special care being taken not to damage the pipe or joints. Use of compaction equipment directly above semi-rigid and flexible pipe should be avoided until sufficient backfill has been placed to ensure that the equipment will not damage the pipe. A minimum of 36 inches of compacted backfill above the top of semi-rigid and flexible pipe will

be in place before wheel loading and a minimum of 48 inches of compacted backfill before use of pneumatic tampers. From these elevations to the subgrade elevation of the pavement, bottom of the sod, or to the original ground surface, suitable backfill will be mechanically placed in 9 inch, maximum, loose layers. All backfill material will be compacted to 95 percent of maximum density at plus or minus 2 percent of optimum moisture content as determined by Laboratory Standard Proctor Test (ASTM D 698).

b. Manholes and Special Structures:
When the masonry or concrete work has set sufficiently to withstand compaction, and the Engineer authorizes, backfill material will be placed in 6 inch loose layers and compacted with heavy tampers or pneumatic tampers to 95 percent of maximum density at plus or minus 2 percent of optimum moisture content as determined by Laboratory Standard Proctor Test (ASTM D 698). Suitable backfill will be placed in this manner from the foundation of the structure to the subgrade elevation of the pavement, the bottom of the sod or to the original ground surface.

C. Open Areas and Unimproved Property

1. Backfill Material:

Backfill of excavations on unimproved property will be made with select material from the top level of bedding material or foundation to the surface. Non-granular select material to be used for backfill will be free from debris, organic matter and perishable compressible material, and will contain no stones, lumps or rock fragments larger than 6 inches. Rocks or lumps smaller than 6 inches in diameter will not exceed an amount that will interfere with the consolidating properties of the fill material. No rocks or lumps will come in direct contact with the pipe. Stones and lumps will be kept separated and well distributed, and all voids will be completely filled with fine material.

2. Placement of Backfill:

Backfill procedures specified in Specification Section 02530 Paragraph 3.11.B will apply from the trench bottom to a point 2 feet above the outside of the pipe. From this point to slightly above the surrounding surface elevation, suitable backfill may be placed by bulldozer or other mechanical means.

D. Sanitary Sewer Facilities Placed on Fill

1. All sanitary sewer pipe laid on fill will be ductile iron pipe. Fill material placed in areas over which sanitary sewer facilities will be constructed will be select, job-excavated earth from the original ground to the subgrade elevation of the facility.

2. The fill material will be placed in 6 inch loose layers and compacted to 95 percent of maximum density at plus or minus 2 percent of optimum moisture content as determined by Laboratory Standard Proctor Test (ASTM D 698) up to a point at least 2 feet above the outside top of the pipe or to the foundation of manholes or special structures. If compaction standards for the sanitary sewer exceed that of the adjoining fill, the width of compaction for a sanitary sewer will be not less than the outside diameter of pipe plus 10 feet. If compaction standards for the sanitary manhole or special structure exceed that of adjoining fill, the limits of compaction for the structure will be not less than 5 feet outside the structure base slab.

E. Removal of Excess Material

1. After the trench or excavation has been properly backfilled, all excess dirt will be removed from the streets, roadways and improved private property so pavements or turfed areas may be replaced and properties cleaned.

2. In open areas and unimproved property, the excess material may be used to fill low spots on property next to the right-of-way/easement. Before spreading excess soil, the Contractor will obtain written permission from the property owner for the spreading of excess soil, and a copy of the written permission will be submitted to the Engineer. Such spreading or filling will not obstruct surface drainage and be to the satisfaction of the property owner. Excess material will be disposed of by the Contractor.

3.12 TUNNELING, BORING, AND JACKING

A. General

1. Sewer pipe will be constructed by tunneling, boring, or jacking only at those locations shown on the plans or directed by the Engineer. Carrier pipe for these applications will be of the type specified in the Plans and Specifications. Grade and alignment will be maintained through all liner pipes. The Contractor will submit shop drawings detailing the method, equipment and material to be used for tunneling, boring and jacking operations to the Engineer for review and approval. The approval by the Engineer of any drawings or plans will not in any way be deemed to release the Contractor from full responsibility for complete and accurate performance of the Work according to the Contract Drawings and Specifications.

2. When tunneling, boring, or jacking is required under railroads, highways, streets, or other facilities, construction will not interfere with the operation of the railroad, street, highway, or other facility and will not weaken or damage any embankment or structure. No water shall be introduced into any tunneling, boring or jacking excavation that lies within City, State or Rail Road right-of-way. A boring that uses a bentonite slurry may be allowed at the discretion of the Engineer and the owner of the right-of-way.

3. The Contractor will be responsible for protection of utilities and sewers against damage by his work. If any utility above or near the tunnel is endangered or has been damaged because of the construction operations, the utility owner will be notified immediately and will be given access to the area to carry out all necessary repairs to such utilities. If any sewers are damaged, it will be the responsibility of the Contractor to make the necessary repairs. If any public or private property is endangered or has been damaged due to tunneling, boring, or jacking operations, it will be repaired at the Contractor's expense. All cost and expense to the Contractor of carrying out the above requirements will be considered included in his bid prices for the completed sewer installation.

4. Access pits will be of sufficient size to provide ample working space for the jacking or boring equipment, reaction blocks, bracing, liner plates, spoil removal, and 2 sections of pipe. Provisions will be made for the erection of guide rails in the bottom of the pit where applicable. If drainage is to be discharged from the jacking pit, a collection sump will be provided. Wherever end trenches are cut in the sides of the embankment or beyond it, such work will be sheeted securely and braced satisfactorily to prevent earth caving.

5. The Contractor will furnish and operate all necessary pumping equipment of ample capacity and arrange to keep tunnels and shafts free of water during construction and to dispose of water satisfactorily. During placement of concrete, drainage and pumping will be arranged so concrete is placed in dry conditions. No water will flow over the concrete until it has set and will not be damaged.

B. Tunneling

1. The Contractor will carry out the work of tunneling so there will be no cave-in or heaving of earth or other material into the tunnel excavation. If there should be any fall or movement of earth into the tunnel, the Contractor will proceed with the work with all necessary precautions to insure the safety of life and of sewers, utilities and public and private property above and near the tunnel.

2. The Contractor will furnish, place, and maintain all sheeting, bracing, lining or casing required to support the tunnel until the pipe and its bedding, jointing, encasement, and backfilling have been completed. All liners will remain in place.

3. Care will be used in trimming the surfaces of the excavated section and in placing the liners or sheeting and bracing so that the required minimum clearance between the outside of the pipe and the final position of the liners, sheeting and bracing in the tunnel will be attained without any deviation in sewer alignment. Sheeting or lining must be placed and held tightly against the trimmed earth surface of the excavated section so that there will be no voids between the earth and the lining or sheeting.

4. No part of the lining, bracing, or flanges of steel liner plates will project closer to the outside of the pipe or pipe bells than the clearance limits shown on the Plans, or a minimum of two inches, if not shown on the Plans.

5. If timber is used for lining and bracing instead of steel liner plates, invert struts will be placed at the required intervals but in such manner that the pipe and its bedding will be supported entirely by the original earth floor of the tunnel and not on timber lining or bracing. All timbers, when placed for the support of the roof and sides of the tunnel, will be properly fitted and wedged in place. Timber sets in tunnels will be abutting. All voids behind timbers will be filled with blocking or other suitable material.

6. Timbering will be designed and placed to allow the filling of voids. All excavated material not required for backfilling abandoned shafts will be removed from the site and disposed of by the Contractor at his expense.

7. Shafts will be constructed at the location shown on the Plans. Temporary construction shafts will be of adequate size and properly constructed and equipped to meet all safety requirements. All shafts will be barricaded, lighted, fenced, and properly guarded from the beginning of the excavation until the completion of the construction requiring the shaft.

8. Provision will be made at all shafts so that plumb lines suspended on the centerline of the sewer at each end of the shaft will hang freely from the surface.

9. A ladder meeting OSHA requirements will be provided in each shaft and will be kept in safe, good repair, clean and clear of debris.

10. Cavities between the surfaces of excavation and the tunnel liner plates or sheeting will be completely filled with a uniform sand cement grout consisting of 1 part portland cement and 7 parts sand and the minimum amount of water necessary for proper placement. Grout will be placed under pressure through grout holes in the steel liner plates or sheeting. The grout holes will be located and the grout placed in such sequence to insure the complete filling of all cavities and to transfer the load from the undisturbed material to the tunnel lining or sheeting uniformly.

11. After the tunnel section is excavated, lined, and braced, the pipe will be placed on and supported by steel rails or other approved supports. The supporting system will assure line and grade and will allow space below the pipe for concrete grout. Care will be used to avoid damage to the pipe and the liner plates.

12. The space between the pipe and the tunnel will be completely grouted with a mixture of sand and portland cement, mixed in the proportions of 1 part cement to 7 parts sand by volume and a minimum amount of water necessary for proper placement whether placed under pressure or by hand.

13. Temporary shafts will be completely abandoned. Unless otherwise specified in the Plans or Contract Documents all sheeting, bracing, and similar items may be removed unless the Contractor requests and receives authorization from the Engineer to leave it in place. No payment will be made for items left in place at the Contractor's option. If the Plans or the Engineer requires leaving the sheeting, bracing, and similar items in place, measurement will be made as provided in Specification Section 02530 Part 5 and payment will be made as provided in

C. Boring

1. When required by the Plans, sewers will be installed in bored holes. The holes will be bored from the downstream end, unless site conditions dictate otherwise and the Engineer approves.

2. The boring machine to be used will be in good condition and capable of drilling the bore hole within the required limits of accuracy. A smooth liner of sufficient strength will be forced into the bored hole to give a tight fit against the earth sides of the bore hole and still provide a uniform clearance of at least two inches around the pipe flange to permit pressure grouting. The liner pipe will be carefully inspected to insure that the carrier pipe can be properly placed.

3. All carrier pipe shall be mechanical joint or restrained joint pipe. Manholes at the ends of a section of bored pipe will not be constructed until the bored section is completed.

4. The following procedures will be used for carrier pipe 18 inches and larger in diameter. The assembled pipe will be placed in the bored hole with approved, non-metallic, casing spacers attached. Casing spacers will be attached in accordance with the manufacturer's recommendations and with a casing spacer installed within 6 inches of each end of the bore. The assembled pipe will be placed in the bored hole only by such method that will keep the joints in compression. Any method that disjoints the pipe while being placed will not be permitted.

5. The ends of the bore shall be sealed with an approved, flexible end seal. The end seals shall be attached in accordance with the manufacturer's recommendations using stainless steel hardware.

6. When unforeseen obstructions or conditions require abandonment of a partially completed bore hole, and the starting of a new hole, the Contractor will grout the abandoned bore hole solid. The Contractor will receive no compensation for any expenses incurred by any unsuccessful attempt.

D. Jacking

1. The Contractor will furnish for the Engineer's review, a plan showing his proposed method of jacking, including the design for the jacking head, jacking support or back stop, arrangement and position of jacks, pipe guides, and similar items in the assembled position. The review of this plan by the Engineer will not relieve the Contractor from his responsibility to obtain the specified results.

2. Heavy duty jacks suitable for forcing the pipe through the embankment will be provided by the Contractor. In operating jacks even pressure will be applied to all jacks used. A suitable jacking head and bracing between jacks and jacking head will be provided so that pressure will be applied to the pipe uniformly around the circumference of the pipe. A suitable jacking frame or backstop capable of resisting the jacking forces will be provided. The pipe to be jacked will be set on guides, properly braced together to support the section of the pipe and to direct it in the proper line and grade. The whole jacking assembly will be placed to line up with the direction and grade of the pipe. The Contractor may use a cutting edge of steel plate around the head end of the pipe extending a short distance beyond the end of the pipe with the inside angles or lugs to keep the cutting edge from slipping back onto pipe.

3. The pipe will be jacked from the downstream end. Manholes at the ends of a section of jacked pipe will not be constructed until jacked section is completed.

4. Any pipe damaged in jacking operations will be removed and replaced by the Contractor at his own expense. Embankment material will be excavated just ahead of the pipe and material removed through the pipe, and the pipe forced through the embankment with jacks, into the space thus provided.

5. The excavation for the underside of the pipe, for at least one-third of the circumference of the pipe, will conform to the contour and grade of the pipe. A clearance of not more than 2 inches may be provided for the upper half of the pipe. This clearance is to be tapered off to zero at the point where the excavation conforms to the contour of the pipe.

6. The distance that the excavation will extend beyond the end of the pipe depends on the character of the material, but it will not exceed 2 feet in any case. This distance will be decreased if the character of the material being excavated makes it desirable to keep the advance excavation closer to the end of the pipe.

7. A cushion material will be placed in the joints between each pipe section adequate to distribute the jacking forces around the entire periphery of the pipe uniformly.

8. When jacking of pipe is begun, the operation will be carried on without interruption, as much as practicable, to prevent the pipe from becoming firmly set in the embankment.

9. The pits or trenches excavated to allow jacking operations will be backfilled immediately after the jacking of the pipe has been completed according to Specification Section 02530 Paragraph 3.11.

10. When unforeseen obstructions or conditions require abandonment of a partially completed pipe jack, the Contractor will grout the abandoned pipe solid. The Contractor will receive no compensation for any expenses incurred by any unsuccessful attempt.

E. Sewer Pipe in Jacked Liner

1. When required by the Plans or Contract Documents, a sewer pipe will be installed by jacking a pipe as a liner and inserting a carrier pipe of required size, type, and class. When using jacking for liners, the steel liner will be welded steel, 35,000 psi yield strength, and of the diameter and wall thickness required on the Plans and Specifications. The Contractor will provide, at his own expense, thicker walled pipe if necessary to withstand the forces of jacking. In any case, the Contractor will retain full responsibility for the adequacy of this jacking operation, equipment and material.

F. Reserved.

3.13 DELETED

3.14 FINAL GRADING

A. Final grading around sanitary sewer facilities will conform to the elevation of adjacent undisturbed ground or as shown on the Plans. Sufficient grading will be done to provide adequate drainage.

3.15 CLEANING

A. All necessary precautions will be taken to prevent the entrance of mud, sand, or other obstructing material into the pipelines. As the work progresses, the interior of the sewer will be cleaned of all dirt, jointing material and extraneous material. On small pipe where cleaning after laying may be difficult, a squeegee will be kept in the pipeline and pulled forward past each joint immediately after its completion. Before final inspection the Contractor will remove all debris and foreign material.

PART 4 - FINAL TESTING AND ACCEPTANCE

4.01 VISUAL INSPECTION

A. All work will be subject to visual inspection for faults or defects and any such deviation or omission will be corrected at once. All tests will be made by the Contractor who will provide necessary equipment for testing and lamping the system in the presence of and under the supervision and instructions of the Engineer. Lamp tests will be observed first hand by the Engineer. Each section of sewer line will show a full circle of light when lamped between manholes. All defects located will be corrected before conducting leakage tests.

4.02 LEAKAGE TESTS

A. Leakage tests will be performed on the full length of all sewer lines and manholes in the presence of the Engineer before acceptance. The cost of all testing will be included in the unit price for the item being tested.

B. Exfiltration Leakage Test

1. This section will only apply to pipe larger than 24 inches and smaller than 48 inches in diameter. All pipe over 48 inches in diameter will have individual joint testing according to Specification Section 02530 Paragraph 4.02.E. The method of testing used by the Contractor will be subject to approval by the Engineer. The Contractor will provide all required testing apparatus. The method adopted must exert a minimum internal water pressure of four feet. This hydrostatic head will be measured from the inside top of the pipe at the high end of the section being tested. The height of the water level at the beginning of the test must be high enough so that the 4-foot head will be standing at the end of the test. The maximum hydrostatic head is limited to 15 feet. The exfiltration test will be maintained for at least two hours on each reach between manholes as necessary to find all leaks. The trench and backfill are intended to be free of excess water.

2. In areas where groundwater is known to exist, a one-half inch diameter capped pipe nipple approximately 10 inches long will be installed through the manhole wall on top of the lowest sewer line entering the manhole. This will be done at the time the sewer line is installed. Immediately before the performance of the leakage test, the groundwater level will be determined by removing pipe cap, blowing air through pipe nipples into the ground to clear it, and then connecting a clear plastic tube to the nipple. The tube will be held vertically and a measurement of height in feet of water will be taken after the water stops rising in this plastic tube. The height in feet will be divided by 2.3 to establish the pounds of pressure that will be added to all readings. In the event there is water present in the trench or backfill at the time of the test, the required head producing the pressure inside the pipe must be raised to offset the counteracting pressure outside of the pipe. The test will not be considered satisfactory until an acceptable method of measurement shows that the exfiltration rate does not exceed 0 gallons per inch of internal diameter per mile of pipe per day for each reach tested.

3. An initial test must be arranged by the Contractor so that the first reach of each size laid by each crew at the beginning of the work day can be tested before the backfill has been completed, but the pipe will be backfilled to a point 2 feet above the outside top of the pipe. This test reach is intended to extend only to the next proposed manhole location. However, if conditions justify, the length of the test reach may be reduced but never will this reach be less than 100 feet. No further pipe laying will be permitted by this crew until the above described test has been satisfied. All remaining pipe will be subject to the exfiltration test after manholes have been constructed and backfill placed. Manholes are to be included in this test and will be considered as sections of pipe equal to the diameter of the manhole.

4. If anytime the exfiltration observed and measured by the Engineer exceeds 0 gallons per inch of internal diameter per mile of sewer per day, the Contractor will find the point(s) of leakage and will make necessary repairs and then retest the same reach. The Contractor will submit his plans for repair to the Engineer for his review.

5. Water used for testing will be removed from the test reach following acceptance and will be disposed of properly. Water used for testing will not be discharged in such a manner to damage other construction or public or private property. The cost of providing the test water will be borne by the Contractor.

C. Air Leakage Test for 6-24 inch Diameter Pipe

1. Upon completion of construction, or earlier if the Engineer deems advisable, the Contractor will provide the necessary equipment and labor to perform low pressure air tests according to ASTM F1417. This test will be performed in the presence of the Engineer and will be for all types of gravity sewer pipe. This test will also include service lines from manholes.

2. The pressure test gauge will meet the following minimum specifications:

Size (diameter)	4 ½ inches
Pressure Range	0-15 PSI
Figure Intervals	1 PSI Increments
Minor Subdivisions	0.05 PSI
Pressure Tube	Bourdon Tube or diaphragm
Accuracy	Plus or minus 0.25% of Maximum scale reading
Dial	White coated aluminum with black lettering, 270□ arc and mirror edges
Pipe Connection	Low male ½ inch NPT

3. Calibration data will be supplied with all pressure test gauges. Certification of pressure test gauges will be required from the gauge manufacturer. This certification and calibration data will be available to the Engineer whenever air tests are done.

4. Air leakage tests will be performed on each reach of sewer pipe between manholes after completion of the installation of pipe and appurtenances and the backfill of sewer trenches. The test time will be determined from the following table. If air tests fail to meet the following requirements, repeat tests as necessary after all leaks and defects have been repaired. Before acceptance, the same sewer reach will pass the low pressure air test.

Time Required for a 1.0 psig Pressure Drop for Size and Length of Pipe Indicated [1]

Pipe Diameter (in.)	Minimum Time (min:sec)	Test Time for Length of Sewer Tested (min)
6	5:40	.854 X L(ft)/60
8	7:34	1.52 X L(ft)/60
10	9:26	2.374 X L(ft)/60
12	11:20	3.418 X L(ft)/60
15	14:10	5.342 X L(ft)/60
18	17:00	7.692 X L(ft)/60
21	19:50	10.47 X L(ft)/60
24	22:47	13.674 X L(ft)/60

1. Establish the test time for the sewer length from the formula or the minimum time, whichever is greater.

D. Infiltration Test

1. Infiltration tests may be required for the complete line or any portion of it. Failure of any part of the line to pass an infiltration test will be sufficient reason to require additional work by the Contractor to reduce the infiltration in such portions of the line tested. The passing of an infiltration test will in no way relieve the Contractor of any responsibility to repair visible leaks found during the visual inspection.

2. Maximum allowable infiltration will be 0 gallons per mile per inch of diameter of sewer per 24-hour day at a time. The joints will be tight, and visible leakage in the joints of leakage greater than that specified above will be repaired at the Contractor's expense by any means necessary.

E. Joint Acceptance Testing

1. Individual joints will be tested for pipe diameters of 48 inches and greater. Testing will be performed according to ASTM C 1103.

4.03 DEFLECTION TEST - SEMIRIGID AND FLEXIBLE PIPE

A. All polyvinyl chloride (PVC) pipe and glass fiber reinforced polymer mortar pipe will be tested for deflection. All testing will take place after backfill has been in place at least 30 days. All lines will be thoroughly cleaned before testing to assure accuracy.

B. Tests will be run using a rigid ball or nine arm mandrel having a diameter of 95% of the inside diameter of the pipe for PVC and 96% of the inside diameter of the pipe for glass fiber reinforced polymer mortar pipe. The mandrel will be pulled freely by hand through the pipe from manhole to manhole. No pipe deflection will exceed 5% for PVC and 4% for glass fiber reinforced polymer mortar pipe. Any section failing the test will be repaired by re-bedding or pipe replacement and retested to the satisfaction of the Engineer.

C. The cost of this service will be included in the unit price bid for the pipe.

4.04 SEWAGE FORCE MAINS

A. The Contractor will perform hydrostatic pressure and leakage tests concurrently conforming to AWWA C 600, AWWA C 605, ASTM D 2774 or ASTM F 2164 procedures as applicable and as modified herein. Tests will apply to all sewage force mains after backfilling.

B. Force mains will be tested separately in segments between sectionalizing valves, between a sectionalizing valve and a test plug, or between test plugs. Select test segments such that adjustable seated valves are isolated for individual checking. The Contractor will furnish and install test plugs at no additional cost, including all anchors, braces and other devices to withstand hydrostatic pressure on plugs. The Contractor will be responsible for any damage to public or private property caused by failure of plugs. Limit water fill rates of line to available venting capacity.

C. Hydrostatic Pressure Test
Conduct tests at 1.5 times maximum operating pressure determined by following

P_{pt} = 0.650 (OP-GE), in which

P_{pt} = test pressure in psi at gauge elevation
OP = operating pressure in feet as indicated for highest elevation of the hydraulic gradient on each section of the line
GE = elevation in feet at center line of gauge

D. Hydrostatic Leakage Test
Conduct tests conforming to AWWA C 600, AWWA C 605, ASTM D 2774 or ASTM F 2164 procedures, as applicable, at maximum operating pressure determined by following formula:

P_{lt} = 0.433 (OP-GE), in which

P_{lt} = test pressure in psi at gauge elevation
OP = operating pressure in feet as indicated for highest elevation of the hydraulic gradient on each section of the line
GE = elevation in feet at center line of gauge

E. Satisfactorily complete previously defined pressure tests before determining the amount of leakage. Maximum allowable leakage will be determined by the following formula:

$$L = ND\frac{\sqrt{p}}{7400}$$

L = Allowable leakage in gallons/hour
N = Number of joints in length of pipeline tested
D = Nominal diameter of the pipe, in inches
P = Average test pressure during leakage test, in pounds per square inch, gauge

4.05 FINAL ACCEPTANCE

A. When all work required by the Contract has been completed, the Contractor shall submit to the Engineer written certification from a registered land surveyor that the centerline of each structure is within 2.0 feet of the centerline of the sewer easement or the location designated on the plans. After receiving the surveyor's certification from the Contractor, the Engineer will make a final inspection of

the Work, including any tests for operation. After completion of this inspection the Engineer will, if all things are satisfactory to him, issue to the Contractor a Certificate of Completion certifying that the Work required by the Contract has been completed according to the Contract Drawings and Specifications. However, the Certificate will not operate to release the Contractor or his sureties from any guarantees under the Contract or the Performance Bond. Upon receipt of the Certificate of Completion the Contractor will clean the premises and see that they are in an orderly condition.

4.06 Tracer Wire

A. All new tracer wire installations shall be located using typical low frequency (512 Hz) line tracing equipment, witnessed by the contractor, and engineer, prior to acceptance of ownership. The verification shall be performed upon completion of rough grading and again prior to final acceptance of the project. Continuity testing in lieu of actual line tracing shall not be accepted.

PART 5 - MEASUREMENT

5.01 SITE PREPARATION AND RESTORATION

A. The area to be considered for measurement will be the limit of the construction area in acres unless otherwise directed by the Engineer.

B. When the Proposal Sheet(s) do(es) not contain an item for Site Preparation and Restoration, this work will be required within the construction limits and will not be paid for directly but will be considered as a subsidiary obligation of the Contractor under other contract items.

5.02 UNDERCUT BACKFILL

A. Undercut backfill will be measured by the ton of limestone in place.

5.03 SHEETING AND SHORING DIRECTED TO REMAIN IN PLACE

A. Sheeting and shoring directed to remain in place will be measured by the 1,000 board feet, in place, after being cut off below grade. Sheeting and shoring placed and removed by the Contractor or left in place at the request of the Contractor will not be measured for payment.

5.04 PAVEMENT BACKFILL

A. Pit run gravel or other acceptable material used for backfill under pavements or other areas directed by the Engineer will be measured by the ton of material in place.

5.05 SERVICE CONNECTION REMOVAL AND REPLACEMENT

A. Service connection removal and replacement for construction of sewer facilities will be measured per each, complete in place. Service connections damaged by the Contractor that do not require removal and replacement for construction of sewer facilities will not be measured for payment.

5.06 EXCAVATION

A. All work for excavation, blasting, drainage of trenches and dewatering, backfilling of excavation, compaction, grading, protection of existing utilities, disposal of excess material, and all other similar items included in this section of the Specifications but not covered by a Pay Item herein will be considered obligations of the Contractor under other Pay Items of the Contract.

5.07 SEWER PIPE

A. Sewer pipe length will be measured per linear foot along the centerline of the pipe from center of manhole to center of manhole. When there are special structures, sewer pipe will be measured from inside face to inside face for the various sizes, types, classes or wall thicknesses. No measurement of pipe depth will be made unless changed field conditions result in a change in the Plans by the Engineer.

B. Sewer pipe length measurement will include the length of wyes as measured along the primary axis for all sizes of sewer pipe.

5.08 PIPE WYES

A. Pipe wyes on sewer lines will not be measured for payment, but are incidental to the cost of furnishing and installing sewer pipe.

5.09 SEWAGE FORCE MAIN

A. Sewage force main length will be measured per linear foot along the centerline of the pipe from the point of measurement at the pumping station or valve box shown on the Plans to the end of the force main at its discharge location. Shut-off and relief valves, valve boxes, and thrust blocks are incidental to the construction of the force main and/or pump station and will not be measured for payment.

5.10 DUCTILE IRON PIPE FITTINGS

A. Ductile iron pipe fittings will not be measured for payment, but are incidental to the cost of furnishing and installing ductile iron sewer pipe or inverted siphons.

5.11 SERVICE CONNECTIONS

A. Service connections between sewer main and right-of-way or easement line will be measured per linear foot to the nearest whole foot, along the centerline of the pipe from the outside face of the wye to the end of the reducer, for the various sizes and types constructed.

B. Service connections between a manhole and the right-of-way or easement line will be measured per linear foot horizontally from the inside face of the manhole to the end of the reducer. Drop service connections will be measured per vertical foot from the flow line of the service connection in the manhole wall to the end of the building connection inside the manhole to the nearest whole foot, along the centerline of the pipe for the various sizes constructed. No measurement of service connection depth will be made. Service connection length will include the length of fitting, reducers, and specials as measured along their centerline.

5.12 NON-SHRINKING GROUT

A. Non-shrinking grout for general use as indicated on the plans or as directed by the Engineer will be measured by the cubic yard, complete in place for each type used.

5.13 PLAIN CONCRETE FOR GENERAL USE

A. Concrete for general use including but not limited to pipe bedding, encasement and collars at the locations shown on the Plans or directed by the Engineer will be measured per cubic yard, complete in place for each class used.

5.14 REINFORCED CONCRETE

A. Reinforced concrete including but not limited to pipe encasement and collars at the locations shown on the Plans or directed by the Engineer will be measured per cubic yard, complete in place.

5.15 Tracer Wire

A. Tracer wire and/or appurtenances will not be measured for payment.

5.16 INVERTED SIPHON

A. Inverted siphons constructed according to Plans and Specifications will be measured per lump sum, for each siphon complete in place.

5.17 SEWER IN EARTH TUNNEL

A. Sewers constructed in earth tunnels will be measured by the centerline length for tunnels with liner plate or without liner plate.

B. Measurements will be from the face of the pit to the face of the pit.

5.18 SEWER IN BORED HOLE

A. Sewers constructed in a bored hole will be measured by the centerline length for bored holes with or without liner pipe.

B. If Contractor has requested and has obtained approval to use a bored hole instead of the construction required by the Plans, no measurement of sewers in bored holes will be made.

C. Reserved.

5.19 JACKED SEWER

A. Jacked sewers will be measured by the centerline length from the face of the pit to the face of the pit. If the Contractor has requested and has obtained approval to jack a sewer instead of the construction required by the Plans, no measurement of jacked sewers will be made.

5.20 SEWER IN JACKED LINER

A. Sewers in jacked liner will be measured by the centerline length from the face of the pit to the face of the pit. If the Contractor has requested and has obtained approval to construct a sewer in a jacked liner instead of the construction required by the Plans, no measurement of sewers in jacked liner will be made.

5.21 DELETED

5.22 ABANDONMENT OF EXISTING PIPE

A. Abandonment of existing pipe will be considered as a subsidiary obligation of the Contractor under other Pay Items of the Contract.

5.23 REMOVAL OF EXISTING PIPE

A. Removal of existing pipe will be measured per linear foot, to the nearest whole foot, along the centerline of the pipe to be removed regardless of size, type, or depth. No measurement of existing pipe removal within the limits of excavation for new sewers will be made

PART 6 - PAYMENT

6.01 SITE PREPARATION AND RESTORATION

Payment will be made for Site Preparation and Restoration at the contract lump sum price, which will be full compensation for removal of trees, shrubs, plants, brush, rubbish, fences, manmade obstructions including but not limited to structures, abandoned cars and appliances, building foundations, and all other obstructions as may be directed by the Engineer; the disposal of debris, removing of obstructions, and the restoration of fences, turfed areas, and all other items will be as specified in the Plans and Contract Documents or as directed by the Engineer.

6.02 UNDERCUT BACKFILL

A. Accepted quantities of undercut backfill will be paid for at the contract unit price per ton of limestone furnished and placed, which will be full compensation for undercut excavation, special protection, protection of existing utilities, and backfilling to bottom of facility subgrade elevations, complete in place.

6.03 SHEETING AND SHORING DIRECTED TO REMAIN IN PLACE

A. Accepted quantities of sheeting and shoring directed by the Engineer to remain in place will be paid for at the contract unit price per 1,000 board feet in place after being cut off below grade, which will be full compensation for material only. The cost of placing sheeting and shoring to remain in place will be included in the unit cost of other items. No payment will be made for sheeting and shoring placed and removed by the Contractor or left in place upon request of the Contractor.

6.04 PAVEMENT BACKFILL

A. Accepted quantities of pit run gravel or other acceptable material used for backfill under pavements or other areas designated by the Engineer will be paid for at the contract unit price per ton furnished and placed, which will be full compensation for furnishing, placing and compacting the selected material.

6.05 SERVICE CONNECTION REMOVAL AND REPLACEMENT

A. Accepted quantities of service connections removed and replaced will be paid for at the contract unit price per each for various types of service connections, which will be full compensation for excavation, removal of old service line and appurtenances, furnishing and construction of new service lines, connections to existing service line and appurtenances to remain, and backfilling, complete in place.

B. All pipeline material will be generically the same throughout the project except solid wall PVC pipe service connected to truss pipe mainlines.

6.06 OMITTED

6.07 SEWER PIPE

A. The accepted quantities of all sewer pipe will be paid for at the contract unit price per linear foot furnished and laid for the various sizes, types, classes, or wall thicknesses of pipe, which will be full compensation for material and material testing, excavation, special protection, protection of existing utilities, maintenance of sewage flow, bedding, laying, jointing, cleaning and inspection, conducting acceptance tests, installation of pipe wyes, connection to manholes, adapters and couplings, stoppers, and removal and/or abandonment of existing pipe within the limits of excavation and backfilling outside pavement areas. All pipeline material will be generically the same throughout the project except connecting solid wall PVC pipe service connections to truss pipe mainlines.

6.08 OMITTED

6.09 SEWAGE FORCE MAIN

A. The accepted quantities of sewage force main will be paid for at the contract unit price per linear foot furnished and laid for the various sizes, types and classes or wall thicknesses, which will be full compensation for material and material testing, excavation, special protection, protection of existing utilities, bedding, laying, jointing, fittings, shut-off valves, relief valves, valve pits, thrust blocks, cleaning and inspection, conducting acceptance tests, connection to existing sewer manholes or structures, removal and/or abandonment of existing pipe within the limits of excavation and backfilling outside pavement areas.

6.10 OMITTED

6.11 SERVICE CONNECTIONS

A. The accepted quantities of service connections will be paid for at the contract unit price per linear foot furnished and laid for the various sizes and types. The accepted quantities of drop service connection will be paid for at the contract unit price per vertical foot furnished and installed. The contract unit price will be full compensation for material and material testing, excavation, special protection, protection of existing utilities, bedding, laying, jointing, adapters and couplings, stoppers, reducers, marking reducer, removal and/or abandonment of existing pipe within the limits of excavation and backfilling outside of pavement areas.

6.12 NON-SHRINKING GROUT

A. The accepted quantities of non-shrinking grout for general use will be paid for at the contract unit price per cubic yard, complete in place for each type used, which will be full compensation for material, testing, etc. necessary for the satisfactory completion of the work.

6.13 PLAIN CONCRETE FOR GENERAL USE

A. The accepted quantities of plain concrete for general use including but not limited to pipe bedding, encasement and collars will be paid for at the contract unit price per cubic yard complete in place, which will be full compensation for material, testing, excavation, pipe support, form work, removal of forms, and curing and protection of concrete.

6.14 REINFORCED CONCRETE

A. The accepted quantities of reinforced concrete including but not limited to pipe encasement and collars will be paid for at the contract unit price per cubic yard, complete in place that will be full compensation for material, testing, excavation, pipe support, form work, reinforcing steel, removal of forms, and curing and protection of concrete.

6.15 INVERTED SIPHON

A. Payment will be made for Inverted Siphon at the contract lump sum price, which price will be full compensation for material and material testing, excavation, special protection, cofferdams, temporary bulkheads, maintenance of sewage flow during construction, protection of existing utilities, inlet manhole and outlet manhole with rims and covers, intermediate manholes, siphon pipe and fittings, concrete encasement, conducting acceptance test, removal and/or abandonment of existing pipe within the limits of excavation and backfilling.

6.16 SEWER IN EARTH TUNNEL

A. The accepted quantities of sewers in earth tunnels will be paid for at the contract unit price per linear foot furnished and constructed for the various sizes, which price will be full compensation for material and material testing, pit excavation, sheeting, timber bracing, liner if required, excavation, temporary shafts, pumping, protection of existing utilities, maintenance of sewage flow, pipe, laying pipe, making pipe joints, grouting, cleaning and inspection, conducting acceptance tests and backfilling of pits and shafts.

6.17 SEWER IN BORED HOLE

A. The accepted quantities of sewers in a bored hole will be paid for at the contract unit price per linear foot furnished and constructed for the various sizes, which will be full compensation for material and material testing, pit excavation, sheeting, timber bracing, liner if required, excavation, boring temporary shafts, pumping, protection of existing utilities, maintenance of sewage flow, pipe, casing spacers, laying pipe, making pipe joints, grouting, cleaning and inspection, conducting acceptance test, and backfilling of pits and shafts.

B. Reserved.

6.18 JACKED SEWER

A. The accepted quantities of jacked sewers will be paid for at the contract unit price per linear foot furnished and constructed for the various sizes; the price will be full compensation for material and material testing, pit excavation, jacking equipment and concrete slab foundation, jacking back stop, temporary shafts, pumping, protection of existing utilities, maintenance of sewage flow, pipe, jacking pipe, making pipe joint cushions, cleaning and inspection, conducting acceptance tests, and backfilling of pits and shafts.

6.19 SEWER IN JACKED LINER

A. The accepted quantities of sewers in jacked liner will be paid for at the contract unit price per linear foot furnished and constructed for the various sizes; the price will be full compensation for material and material testing, pit excavation, jacking equipment and concrete slab foundation, jacking back stop, temporary shafts, pumping, protection of existing utilities, maintenance of sewage flow, pipe liner, laying pipe, making pipe joints, grouting, cleaning and inspection, conducting acceptance tests, and backfilling of pits and shafts.

6.20 DELETED

6.21 OMITTED

6.22 REMOVAL OF EXISTING PIPE

A. The accepted quantities of existing pipe removal will be paid for at the contract unit price per linear foot regardless of pipe size or type which price will be full compensation for excavation, special protection, protection of existing utilities, pipe removal, salvage or disposal, backfilling and site restoration.

6.23 Tracer Wire

No separate payment shall be made for tracer wire or appurtenances. Tracer wire and appurtenances shall be considered incidental to the sewer and/or service connection installation.

6.24 PAYMENT WILL BE MADE UNDER:

Item No.	Pay Item	Pay Unit
02530-6.01	SITE PREPARATION AND RESTORATION	Lump Sum
02530-6.02	UNDERCUT BACKFILL	Ton
02530-6.03	SHEETING AND SHORING DIRECTED TO REMAIN IN PLACE	1,000 Board Feet
02530-6.04	PAVEMENT BACKFILL	Ton
02530-6.04.01	DELETED	
02530-6.04.02	Pit Run Gravel Backfill	Ton
02530-6.05	SERVICE CONNECTION REMOVAL AND REPLACEMENT	EA
02530-6.05._____	Type Service Connection	EA
02530-6.07	SEWER PIPE	Linear Foot
02530-6.07.01._____"	Prestressed Concrete Cylinder Pipe	LF
02530-6.07.02._____"	Reinforced Concrete Pipe, Class II	LF
02530-6.07.03._____"	Reinforced Concrete Pipe, Class III	LF
02530-6.07.04.___ ___"	Reinforced Concrete Pipe, Class IV	LF
02530-6.07.05.___ ___"	Reinforced Concrete Pipe, Class V	LF
02530-6.07.06.___ ___"	Ductile Iron Pipe, Class 50	LF
02530-6.07.07.___ ___"	Ductile Iron Pipe, Class 51	LF
02530-6.07.08.___ ___"	Ductile Iron Pipe, Class 52	LF
02530-6.07.09.___ ___"	Ductile Iron Pipe, Class 53	LF
02530-6.07.10.___ ___"	Ductile Iron Pipe, Class 54	LF
02530-6.07.11.___ ___"	Ductile Iron Pipe, Class 55	LF
02530-6.07.12.___ ___"	Ductile Iron Pipe, Class 56	LF
02530-6.07.13	DELETED	
02530-6.07.14.	DELETED	
02530-6.07.15.___ ___"	Polyvinyl Chloride (PVC) Pipe	LF
02530-6.07.16.___ ___"	Glass Fiber Reinforced Polymer Mortar Pipe	LF
02530-6.09	FORCE MAIN	LF
02530-6.09.01.___ ___"	Ductile Iron Force Main, Class 50	LF
02530-6.09.02.___ ___"	Ductile Iron Force Main, Class 51	LF
02530-6.09.03.___ ___"	Ductile Iron Force Main, Class 52	LF
02530-6.09.04.___ ___"	Ductile Iron Force Main, Class 53	LF
02530-6.09.05.___ ___"	Ductile Iron Force Main, Class 54	LF
02530-6.09.06.___ ___"	Ductile Iron Force Main, Class 55	LF
02530-6.09.07.___ ___"	Ductile Iron Force Main, Class 56	LF
02530-6.09.08.___ ___"	Polyvinyl Chloride (PVC) Force Main, Class 200	LF
02530-6.09.09.___ ___"	High Density Polyethylene Force Main	LF
02530-6.11	SERVICE CONNECTION	LF
02530-6.12	NON-SHRINKING GROUT	CY
02530-6.12.01	Non-shrinking grout, Type I	CY
02530-6.12.02	Non-shrinking, fast setting grout, Type II	CY
02530-6.13	PLAIN CONCRETE FOR GENERAL USE	CY
02530-6.13.01	Plain concrete for general use, Class A	CY
02530-6.13.02	Plain concrete for general use, Class C	CY
02530-6.14	REINFORCED CONCRETE FOR GENERAL USE	CY
02530-6.15	INVERTED SIPHON	Lump Sum
02530-6.16	SEWER IN EARTH TUNNEL	LF
02530-6.16.01._____	"Sewer in Earth Tunnel With Liner Plate"	LF
02530-6.16.02._____	"Sewer in Earth Tunnel Without Liner Plate"	LF
02530-6.17	SEWER IN BORED HOLE	LF
02530-6.17.01._____	"Sewer in Bored Hole With Liner Pipe"	LF
02530-6.17.02._____	"Sewer in Bored Hole Without Liner Pipe"	LF
02530-6.17.03.	Reserved	
02530-6.18	JACKED SEWER	LF
02530-6.18.01_____	"Jacked Sewer"	LF

02530-6.19 SEWER IN JACKED LINER	LF
02530-6.19.01_____"Sewer in Jacked Liner"	LF
02530-6.22 REMOVAL OF EXISTING PIPE	LF

Examples of Pay Item Numbering System for Sewer Pipes

02530-6.07.03.48	Pay Item Number
02530-6	Section of Specification
.07	Last digit(s) of applicable paragraphs for payment
.03	Type of Pipe: e.g., Reinforced Concrete, Class III
.48	Size of Pipe; e.g., 48" diameter

END OF SECTION 0253